SMAST Technical Report 09-0203

Transient Tidal Eddy Project Data Report: Spring 2008

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I. General Information

The Transient Tidal Eddy (TTE) project consisted of field and modeling components that focused on a better understanding of the kinematics and dynamics of tidal eddy motion generation and evolution in the Great South Channel region east of Chatham, MA (see Figure 1). The project divided its observational activities into a strongly stratified phase in spring 2008 and a weakly stratified phase in winter 2008-09. This report focuses on the TTE spring observation phase, which consisted of shipboard CTD and ADCP surveys, and CODAR surface current mapping between 6 and 30 May 2008.

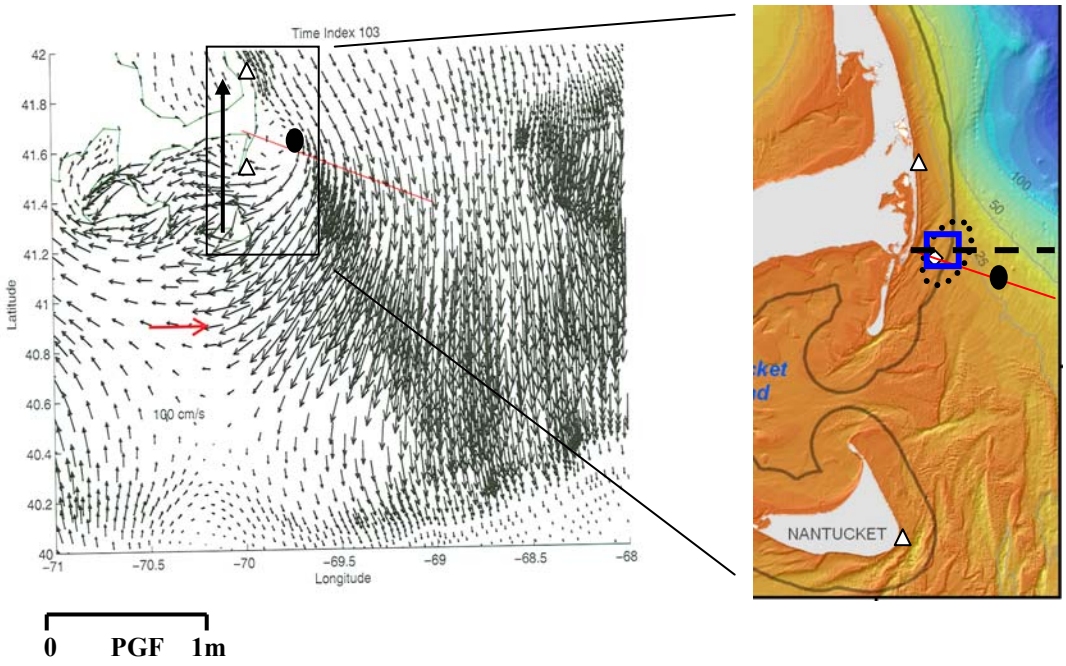

Figure 1 (right) The site of the field measurement program with elements: the Nauset and Nantucket CODAR sites (triangles), water property measurement transect (black dashed), AUV sampling box (blue), bottom-mounted ADCP/pressure 30m mooring site (diamond); and the NSD mooring site (filled oval); all relative to a schematic eddy and the reference transect (solid red) against a background of regional bathymetry (Courtesy of B. Butman USGS). **(left)** A model simulation of the full separation of the ebb flow envelop that frames a small clockwise eddy near the coast at 1.55^{hr} before the "change of tide" from ebb to flood flow. The pressure gradient force vector (PGF; northward arrow) is derived from the model sea level difference between the indicated model mesh nodes (triangles; with PGF–scale below). The current scale and reference transect are shown in red. The filled oval marks the NSD mooring site, at which proxy tidal current predictions are made (see below);

The spring 2008 field activities were concentrated in May and consisted of shipboard ADCP

current and CTD profile measurements along a transect depicted in Figures 2a & 2b.

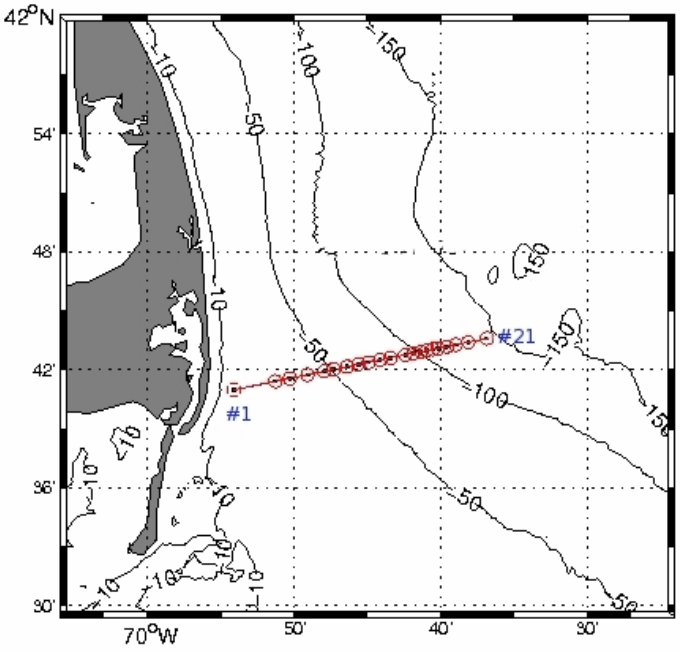

Figure 2a The location map for CTD/ADCP stations 1 to 21.

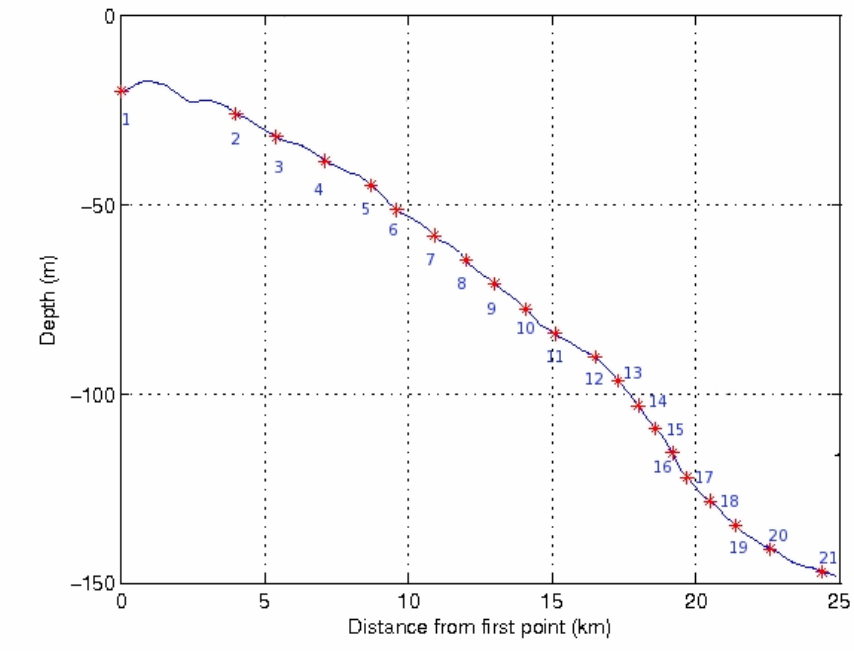

Figure 2b The transect bathymetry along which the standard CTD/ADCP stations are located.

II. Shipboard Measurements

The field surveys were conducted using a commercial fishing vessel called Sea Win, which was 31 ft in length and had a typical cruising speed of 14 knots. The spring shipboard profiling surveys were conducted on 6, 7, and 30 May 2008 respectively; using various combinations of measurement instruments; including (1) an internally- recording Sea Bird Electronics Conductivity/Temperature/Depth (CTD) instrument (SBE-25) and (2) an internally-recording 300 kHz RDI, Inc. Acoustic Doppler Current Profiling (ADCP).

Figure 3 The commercial fishing vessel Sea Win (31 ft long with a typical cruising speed of 14 knots.

A. HYDROGRAPHY

Instrumentation: The hydrographic measurements were conducted using a Seabird® SBE-25 SEALOGGER (Figure 4) that was equipped with pressure (P), temperature (T), and conductivity (C) (as well as oxygen) sensors. The specifications for a calibrated SBE-25 are in Table 1.

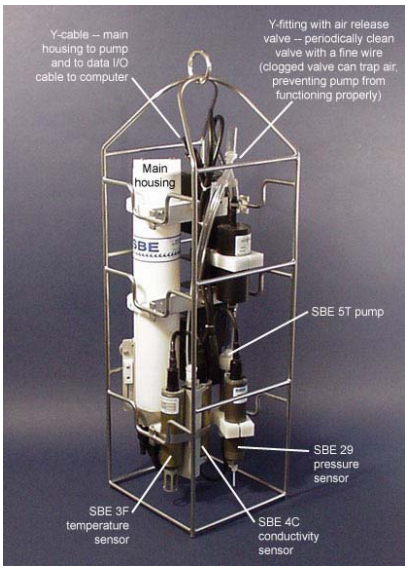

Figure 4 The internally-recording SBE-25 was used to measure temperature, conductivity, and pressure.

Table 1 SBE-25 specifications.

	Temperature (ºC)	**Conductivity (S/m)**	**Pressure (db)**
Measurement Range	-5 to +35	0 to 7	0 to **350**
Accuracy	± 0.002	± 0.0003	± 0.1% of full-scale range
Resolution	± 0.0003	± 0.00004	± 0.015% of full scale range

The SBE-25 is an internally-recording instrument that was configured for these measurements as follows:

- Sample Rate: 8 scans/sec
- Minimum conductivity frequency for pump turn-on: 4000 Hz;
- Record up-cast: on
- Record down-cast: on

This SBE-25 attached to a ¼-inch polypropylene line was lowered at the rate of about 0.5 m/s to within 5-10 meters of the bottom at each station. About every 5 stations, the data were downloaded via an umbilical to a laptop computer and processed. The SeaBird software package SEASOFT was used to covert the raw hexadecimal P/T/C time-series output into engineering units. The salinity was computed from the measured conductivity and temperature; based on the salinity scale of 1980 (Fofonoff and Millard, 1983). The T and S profiles were checked for "reasonableness" onboard.

Back in the laboratory, the down-cast data only were processed using Matlab as follows:

- The time-series P/T/C data files (*.cnv) from SEASOFT were read with the R. Signell (USGS) script called "ctd_rd.m";
- The time series P/T/S data were averaged into 1-decibar (dbar) bins;
- These profile data were stored as ASCII files for post-processing and plotting.

Hydrography Survey - 6 MAY 2008

On the 6 May, the Sea Win departed Harwichport, MA at 8:30 EDT. The ocean was calm during the transit around the Monomoy Island; arriving off-shore of the SMAST Nauset CODAR site at Coast Guard Beach at about 11 am. After a failed attempt at conducting a CODAR beam pattern calibration, we departed for the seaward end of the measurement transect. The Sea Win arrived at the station 21 station to begin the 12 CTD station survey at 1348 EDT; finishing at 1559 EDT (see Table 2).

Representative T and S profiles and T-S relations at stations 9 and 11 (Figure 5) show a snapshot of the spring-time development of the thermocline, halocline, and pycnocline. The vertical sections of temperature, salinity and density anomaly (sigma-t) measurements in Figure 6 are based on the full suite of profiles (see Appendix A).

Table 2 Station Information for the 6 May 2008 Hydrographic Survey.

St	Lat ° N	Lon° W	Depth (m)	Depth (fath)	Time (GMT)	Time (Julian hrs)	NS Dist (nm)	Cum Dist (nm)	NSDist (km)	Cum Dist (km)
1	41 41.010 41. 6835	69 54.095 69.9016	20.8	11.4	1959	949747.983	2.9031	-	5.3766	-
3	41 41.598 41.6933	69 50.288 69.8381	32.6	17.8	1939	949747.650	1.7822	2.9031	3.3007	5.3766
5	41 41.938 41.6990	69 47.945 69.7991	45.5	24.9	1926	949747.433	1.1897	4.6853	2.2033	8.6773
7	41 42.173 41.7029	69 46.383 69.7730	60.5	33.1	1916	949747.267	1.1416	5.8750	2.1142	10.8805
9	41 42.402 41.7067	69 44.885 69.7481	71.9	39.3	1906	949747.100	1.1476	7.0166	2.1254	12.9947
11	41 42.621 41.7103	69 43.376 69.7229	86.7	47.4	1856	949746.933	1.1664	8.1642	2.1602	15.1201
13	41 42.854 41.7142	69 41.845 69.6974	98.6	53.9	1845	949746.750	0.7378	9.3306	1.3664	17.2803
15	41 43.003 41.7167	69 40.877 69.6813	100.9	55.2	1837	949746.617	0.5540	10.0684	1.0261	18.6467
17	41 43.111 41.7185	69 40.149 69.6692	126.9	69.4	1829	949746.483	0.9276	10.6224	1.7180	19.6727
19	41 43.280 41.7213	69 38.927 69.6488	139.7	76.4	1818	949746.300	0.6605	11.5501	1.2233	21.3907
20	41 43.397 41.7233	69 38.056 69.6343	146.3	80.0	1738	949745.633	0.9468	12.2106	1.7534	22.6140
21	41 43.610 41.7268	69 36.820 69.6137	152.2	83.2	1748	949745.800	-	13.1574	-	24.3674

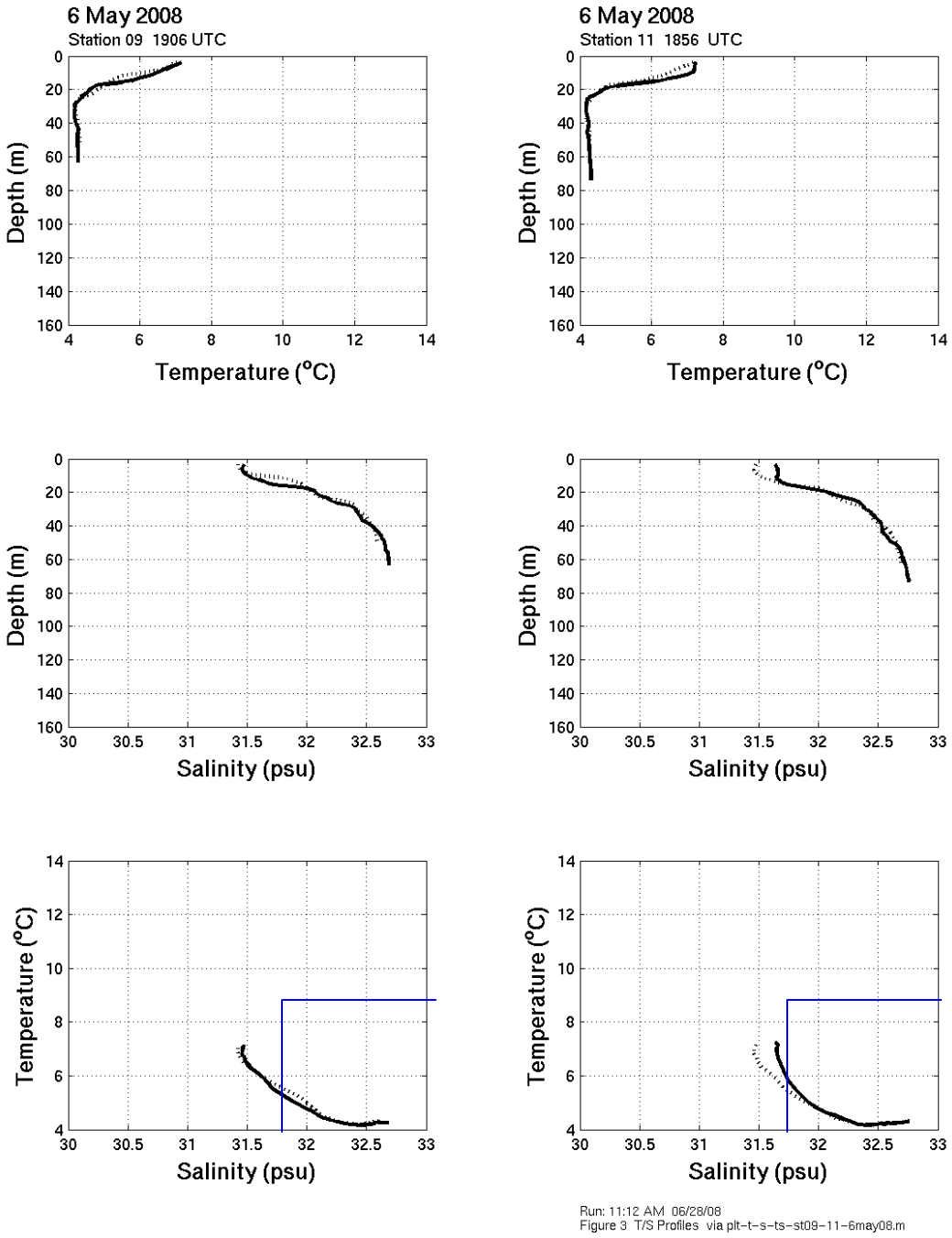

Figure 5 The 6 May 2008 station 9 and 11 **(top)** temperature (T) profiles; **(middle)** salinity (S) profiles; and **(bottom)** T-S relations. The profiles of the preceding station (dotted) are also shown. The box defines Maine Intermediate Water property boundaries.

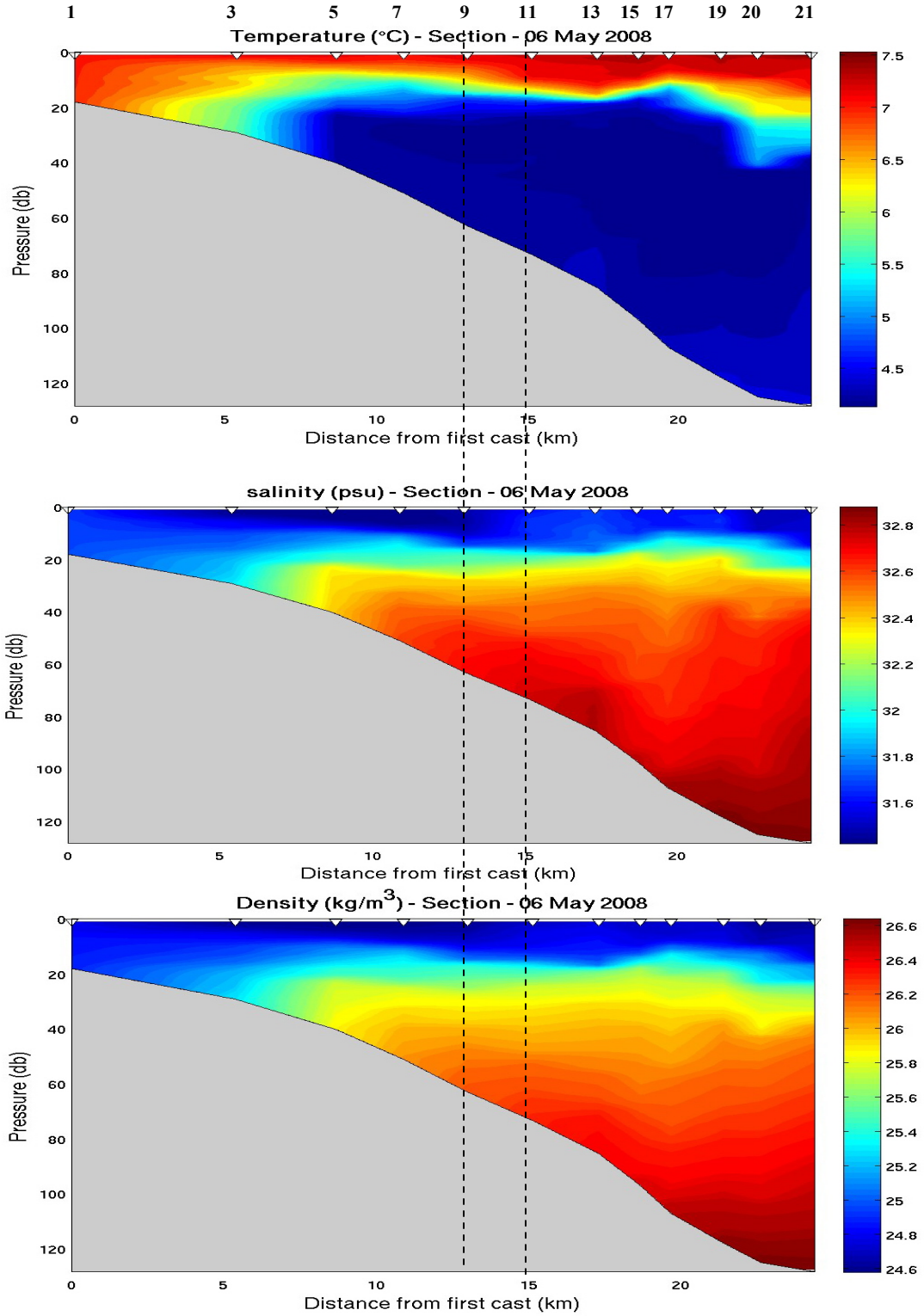

Figure 6 The of 6 May 2008 vertical sections (top) temperature (T in ^{o}C), (middle) salinity (S in psu) and (bottom) density anomaly σ_t were derived from data at the indicated stations. The distance is referenced to station 1. Stations 9 and 11 are located by the dashed lines.

Hydrographic Survey – 30 May 2008

The 30 May 2008 CTD/ADCP stations that were occupied are listed in Table 3. Representative T and S profiles and T-S relations at stations 10 and 12 (Figure 7) show a snapshot of the late spring-time development of the thermocline, halocline, and pycnocline. The vertical sections of temperature, salinity and density anomaly (sigma-t) measurements in Figure 8 are based on the full suite of profiles (see Appendix B). (The corresponding ADCP profiles appear in Appendix E).

Table 3 Station information for the 30 May 2008 survey

St	Lat ° N	Lon	Depth (m)	Depth (fath)	Time (GMT)	Time (Julian hrs)	NS Dist (nm)	Cum Dist (nm)	NSDist (km)	Cum Dist (km)
1	41 41.010 41. 6835	69 54.095 69.9016	21.4	11.7	1224	950316.400	1.0611	-	1.9652	
1a	41 41.247 41.6875	69 52.682 69.8780	19.8	10.8	1245	950316.750	1.0791	1.0611	1.9986	1.9652
2	41 41.455 41.6909	69 51.264 69.8544	26.5	14.5	1300	950317.000	1.6788	2.1403	3.1092	3.9638
4	41 41.794 41.6966	69 49.062 69.8177	39.9	21.8	1319	950317.317	1.3431	3.8191	2.4873	7.0730
6	41 42.053 41.7009	69 47.297 69.7883	52.7	28.8	1335	950317.583	1.2929	5.1622	2.3945	9.5603
8	41 42.307 41.7052	69 45.599 69.7600	67.1	36.7	1353	950317.883	1.1063	6.4551	2.0489	11.9548
10	41 42.528 41.7088	69 44.147 69.7358	79.4	43.4	1414	950318.233	1.3229	7.5614	2.4501	14.0037
12	41 42.801 41.7134	69 42.413 69.7069	92.7	50.7	1431	950318.517	0.7936	8.8843	1.4697	16.4538
14	41 42.962 41.7160	69 41.372 69.68.95	104.4	57.1	1458	950318.967	0.9273	9.6779	1.7173	17.9235
17	41 43.097 41.7183	69 40.143 69.6691	125.3	68.5	1515	950319.250	0.9278	10.6052	1.7183	19.6407
19	41 43.303 41.7217	69 38.931 69.6489	138.3	75.6	1530	950319.500	1.6070	11.5330	2.9762	21.3590
21	41 43.641 41.7274	69 36.826 69.6138	150.5	82.3	1548	950319.800	-	13.1400	-	24.3352

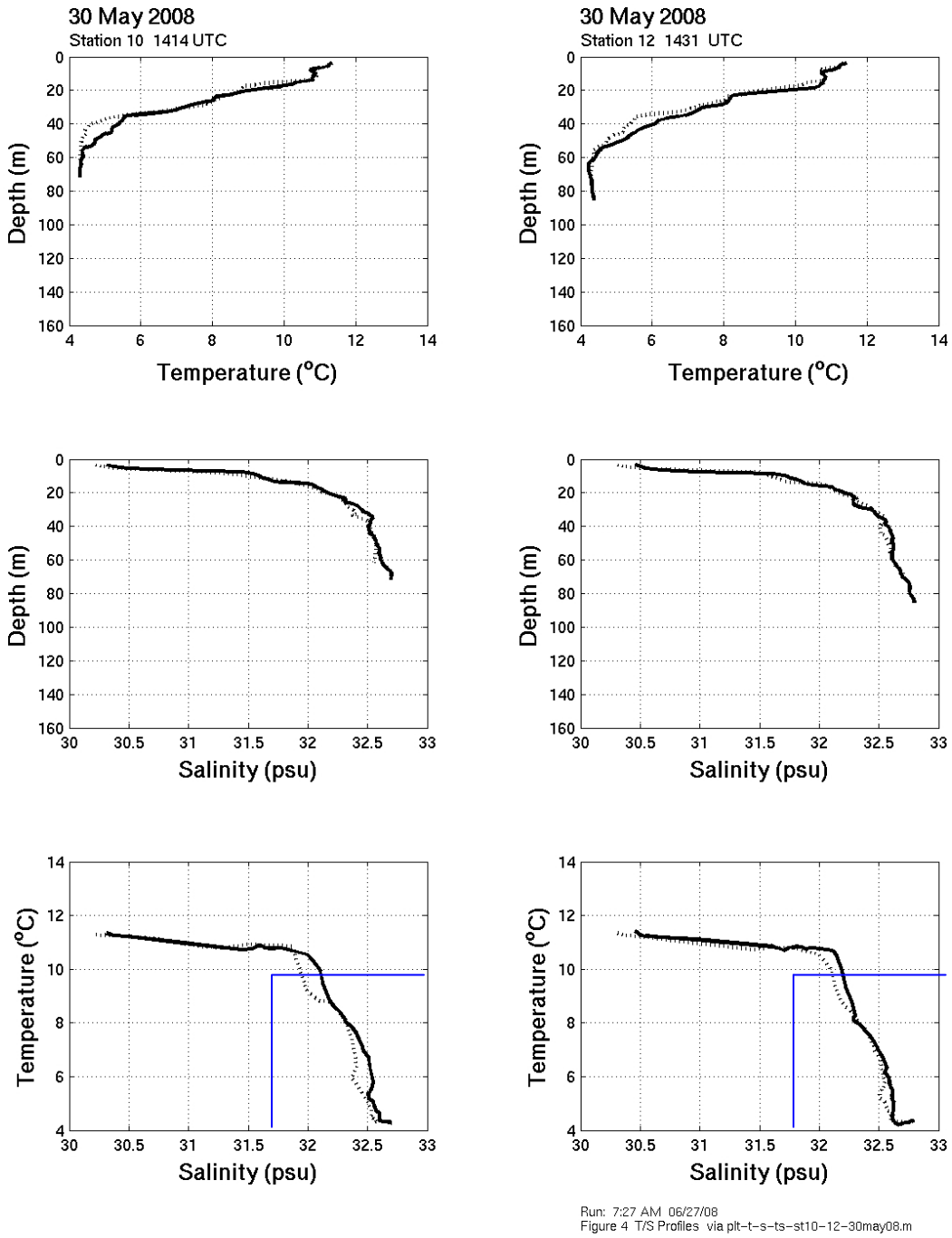

Figure 7 The 30 May 2008 station 10 and 12 profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown. The lines define the limits of the cold, salty MIW mass as defined by Brown and Irish (1993).

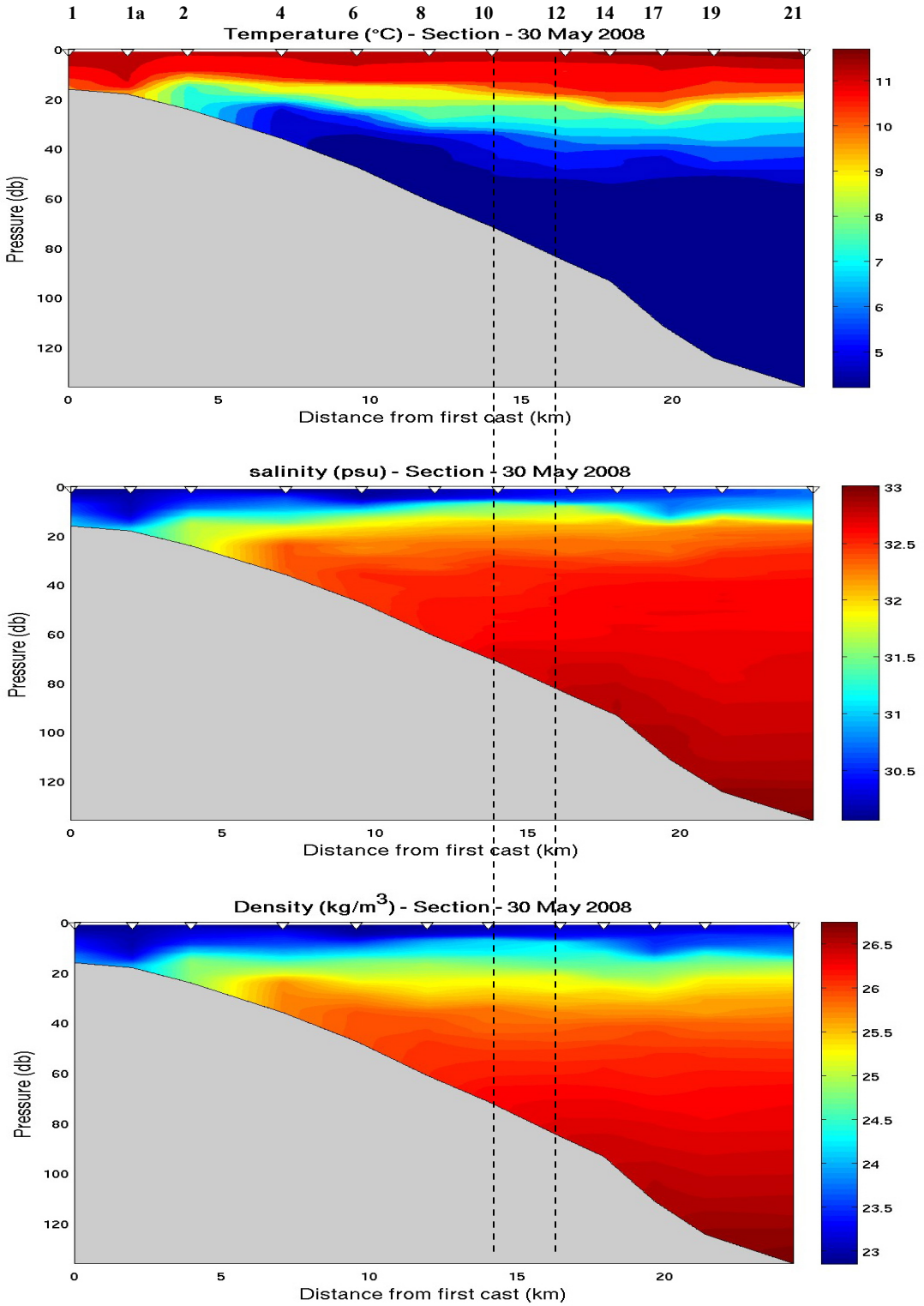

Figure 8 The 30 May 2008 vertical sections of 30 **(top)** temperature (T ^{o}C), (**middle)** salinity (S psu) and **(bottom)** density anomaly σ_t are derived from data at the indicated stations. The distance is referenced to station 1. The station 10 and 12 profile locations are indicated.

Discussion

The comparison of the 6 and 30 May 2008 hydrographic measurements (Figures 6 and 8) highlights the increased stratification of the surface layer due to freshening and warming. This is the process that defines the emerging Maine Surface Water (MSW) in the western Gulf of Maine for 2008. This process distinguishes the deeper Maine Intermediate Water (MIW) water mass, as defined by the Brown and Irish (1993). Both of these water masses are indicated in the Figure 9 T-S diagram for summer 2008.

The vertical sections in Figures 6 and 8 show that the water inshore of station 3 is relatively more well-mixed than that offshore. The pycnocline, which is dominated by the salinity distribution, is strongest at a depth of about 20m between transect stations 7 (59m depth) and 21 (147m depth). The sub-pycnocline waters are primarily Maine Intermediate Water (MIW) as indicated by the MIW property limits in Figures 6 and 9.

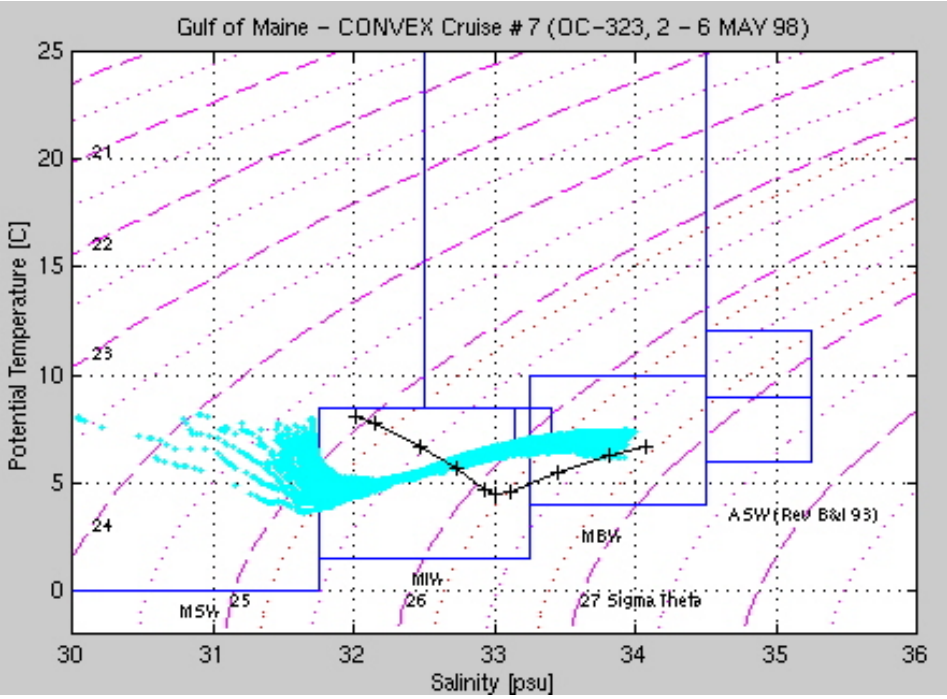

Figure 9 The T-S diagram for hydrographic measurements in the adjacent Wilkinson Basin during 2-6 May 1996. The Maine Intermediate Water (MIW) mass box is of interest.

B. CURRENTS

Subsurface current profiles were measured using a Teledyne RD Instruments Workhorse Sentinel Acoustic Doppler Current Profiler (ADCP) operating at a frequency of 300 kHz. The ADCP was bolted to a rotating spar that was mounted in a cylindrical holder (normally used for fishing rods) on the rail of the 35-foot fishing vessel "Sea Win" (Figure 10). This configuration enabled us to lower the ADCP into the water to the depth of about 1.5 m at each station and then raise it out of the water for steaming to the next station. The ADCP was powered by shipboard power supply through a waterproof cable.

For these measurements, the ADCP data were recorded with a sampling configuration was:

Sample Bin Size:	2m
Number of Bins:	74
First Current Bin Depth:	4.20m below transducer head
Ping Rate:	2/sec
Ensemble Size	10sec (i.e., 20 pins/ensemble)

A summary of some of the technical specifications for the Workhorse 300 kHz ADCP appears in Table 4. In general, velocity accuracy at this frequency is approximately 0.5% of the water velocity relative to the ADCP ±0.5 cm/sec with a resolution of 0.1 cm/sec. These are typical ranges and standard deviations with actual values varying significantly; depending on actual conditions.

Table 4 RDI Workhorse Sentinel 300 kHz ADCP specifications.

Bin Size (m)	1m	2m	4m	8m
Typical Range (m)	92-71	102-78	113-86	126-95
Standard Deviation (cm/sec)	12.8	6.1	3.0	2.0

Figure 10 (left) The RDI 300 kHz ADCP mounted on the deployment spar. **(right)** At each station the downward-looking ADCP was lowered to a depth of about 1.5m.

Current Survey - 7 May 2008

On the 7 May, the Sea Win departed Harwichport, MA at 806 EDT. The weather was very windy producing 3-4 ft ocean waves during the transit around the Monomoy Island to station 1 (see Table 5 for station information). The ADCP current survey measurements made at stations 1 through 11 listed in started at station 1 at 952 EDT and ended at station 11 at 1205 EDT.

Table 5 Station information for the 7 May 2008 hydrographic profile survey The current survey stations are indicated by an (*).

St	Lat ° N	Lon	Depth (m)	Depth (fath)	Time (GMT)	Time (Julian hrs)	NS Dist (nm)	Cum Dist (nm)	NSDist (km)	Cum Dist (km)
1*	41 41.05 41.6842	69 53.85 69.8975	19.6	10.7	1352	949765.867	1.9638	-	3.6370	-
2*	41 41.43 41.6905	69 51.27 69.8545	25.4	13.9	1416	949766.267	0.7513	1.9638	1.3914	3.6370
3*	41 41.60 41.6933	69 50.29 69.8382	32.2	17.6	1420	949766.333	0.9232	2.7151	1.7098	5.0284
4*	41 41.75 41.6958	69 49.07 69.8178	39.3	21.5	1452	949766.867	0.8649	3.6383	1.6017	6.7382
5*	41 41.94 41.6990	69 47.94 69.7990	46.1	25.2	1504	949767.067	0.4908	4.5032	0.9089	8.3399
6*	41 42.08 41.7013	69 47.31 69.7885	52.1	28.5	1514	949767.233	0.6956	4.9940	1.2883	9.2489
7*	41 42.19 41.7032	69 46.39 69.7732	60.5	33.1	1525	949767.417	0.5909	5.6896	1.0943	10.5372
8	41 42.29 41.7048	69 45.61 69.7602	65.0	35.5	1535	949767.583	0.5487	6.2805	1.0161	11.6315
9	41 42.40 41.7067	69 44.89 69.7482	72.2	39.5	1545	949767.750	0.5799	6.8292	1.0740	12.6476
10	41 42.52 41.7087	69 44.13 69.7355	80.5	44.0	1555	949767.917	0.5748	7.4091	1.0645	13.7216
11	41 42.65 41.7108	69 43.38 69.7230	87.4	47.8	1605	949768.083	1.4623	7.9839	2.7082	14.7861

The 7 May 2008 CTD/ADCP stations that were occupied are listed in Table 5. The full suite of ADCP profiles appear in Appendix D. These ADCP current profiles are 100-second average profiles which have been produced by averaging of 10 of measured 10-second scans according to the procedure given in Table 6.

The example in Table 7 is for the 7 May 2008 station 2 (26m depth) ADCP profile data. Specifically, the standard deviations (SD) of the corresponding 100-sec average current component profile is less that most of the SDs of 10 of the 10-second current component profiles; implying a reduced uncertainty and thus an improved precision that comes with averaging noisy data.

The vertical sections of the ADCP current components are presented in Figure 11.

Table 6 The standard deviations (cm/s) of the current component profiles associated with 10 different 10-second scans. In this case for the 7 May 2008 station 2 (26m depth), each vertical profile consists of 12 bins corresponding to the 2m intervals between 4.19 and 26.19 m depth. The 100-sec average (10x10-second scans) current profile for both the eastward and northward current profiles is given

	Eastward Scan#	SD	Northward Scan#	SD
1	eas_02.01	6.05	nor_02.01	5.30
2	eas_02.02	6.68	nor_02.02	7.43
3	eas_02.03	7.23	nor_02.03	5.55
4	eas_02.04	7.46	nor_02.04	5.77
5	eas_02.05	11.44	nor_02.05	6.37
6	eas_02.06	7.51	nor_02.06	6.01
7	eas_02.07	8.10	nor_02.07	4.61
8	eas_02.08	7.09	nor_02.08	5.59
9	eas_02.09	7.62	nor_02.09	6.90
10	eas_02.10	6.35	nor_02.10	4.59
AVE	**eas_02.ave**	**6.68**	**nor_02.ave**	**4.62**

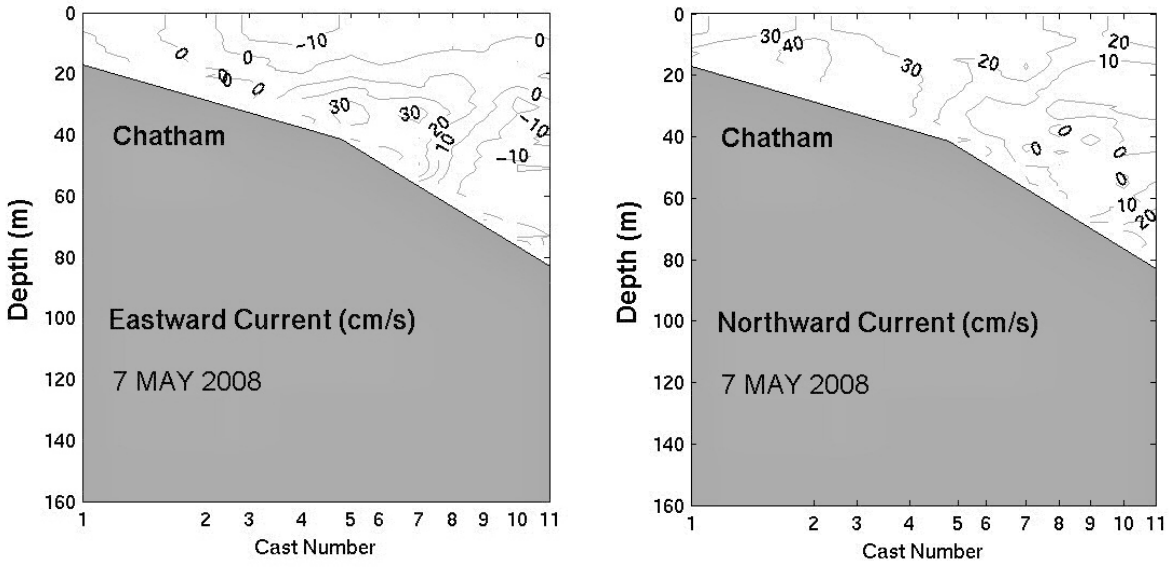

Figure 11 The 7 May 2008 vertical sections of (left) eastward current and (top) northward current.

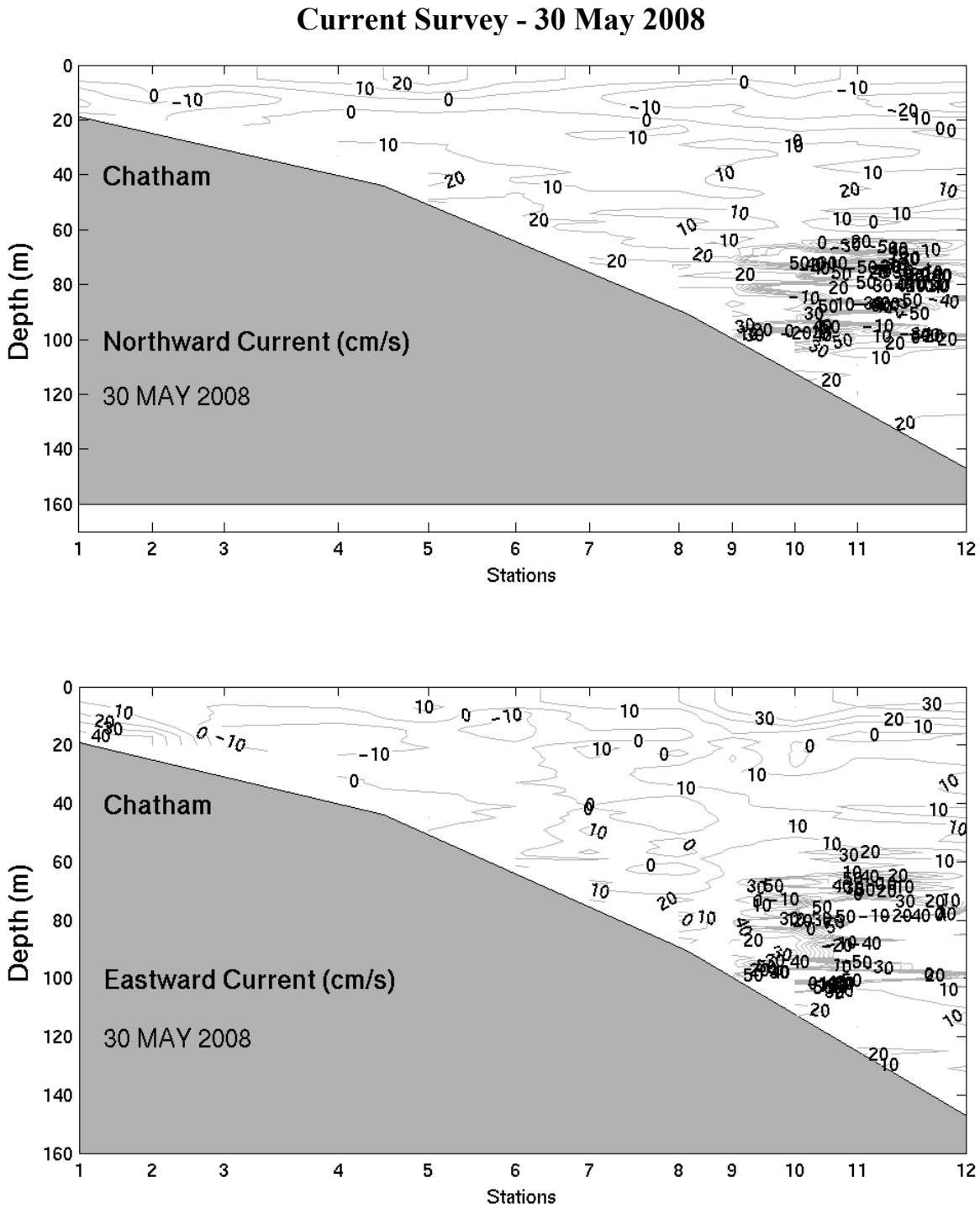

Figure 14 Vertical sections of 30 May 2008 (top) ADCP northward current (V cm/s) and (middle) ADCP eastward current (U cm/s) based on data from the indicated stations whose locations are referenced to station 1.

III. APPENDICES

APPENDIX A. Hydrographic Profiles - 6 May 2008

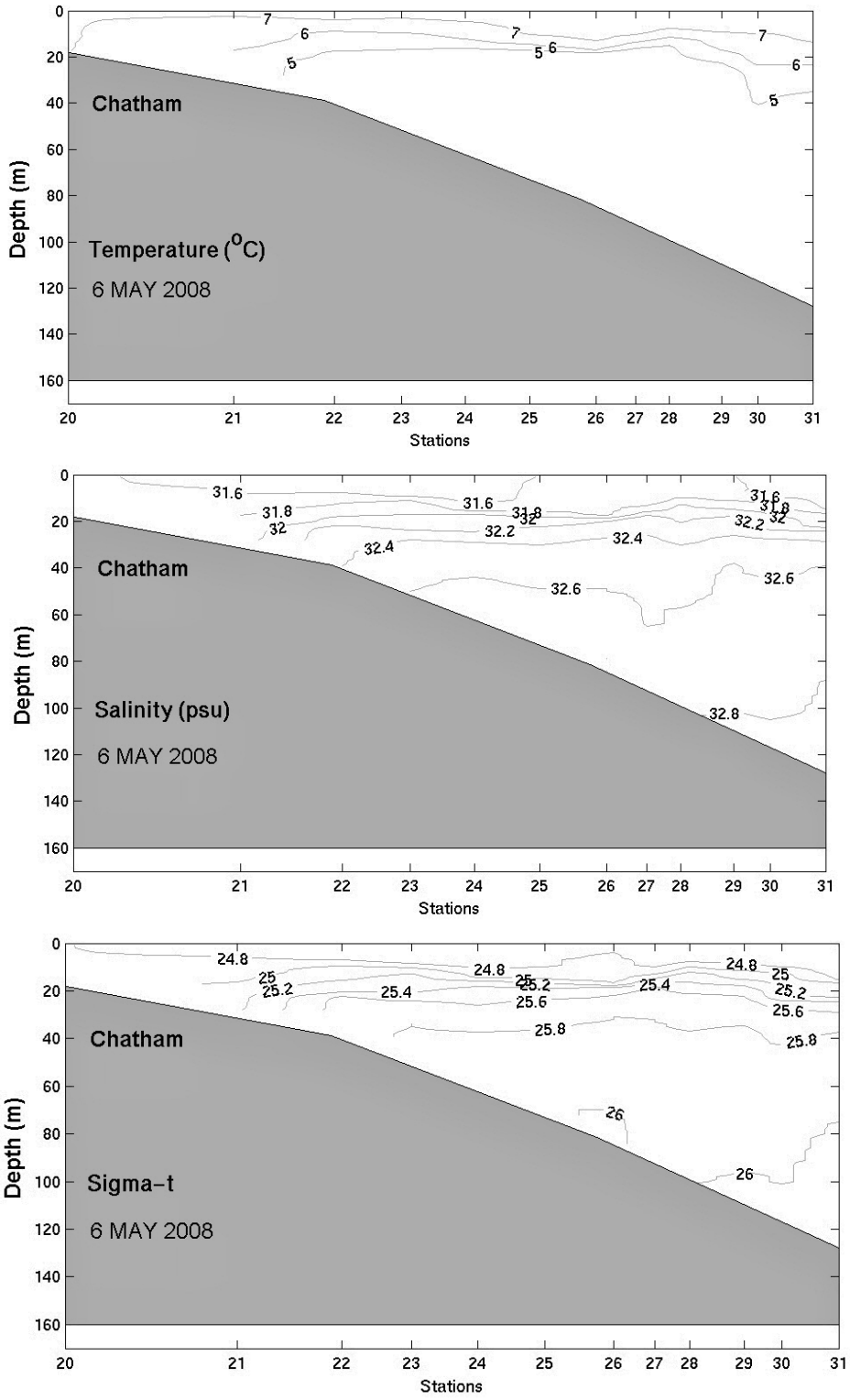

Figure A0 Sections of (top) temperature; (middle) salt; and (bottom) density anomaly for 6 May 2008

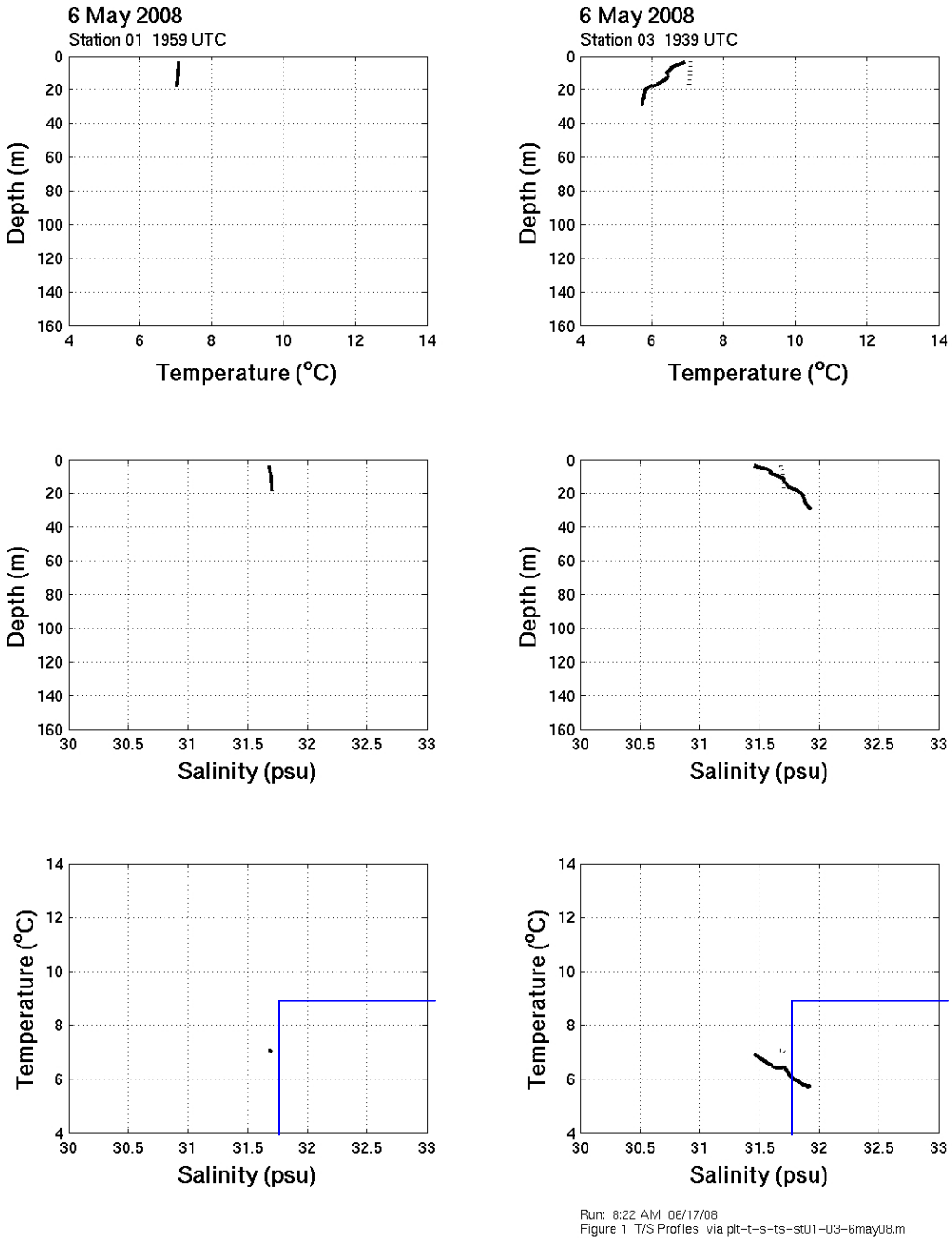

Figure A.1 Station 1 and 3 profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown. See Table 1 for station information. The lines define the limits of the cold, salty MIW mass as defined by Brown and Irish (1993).

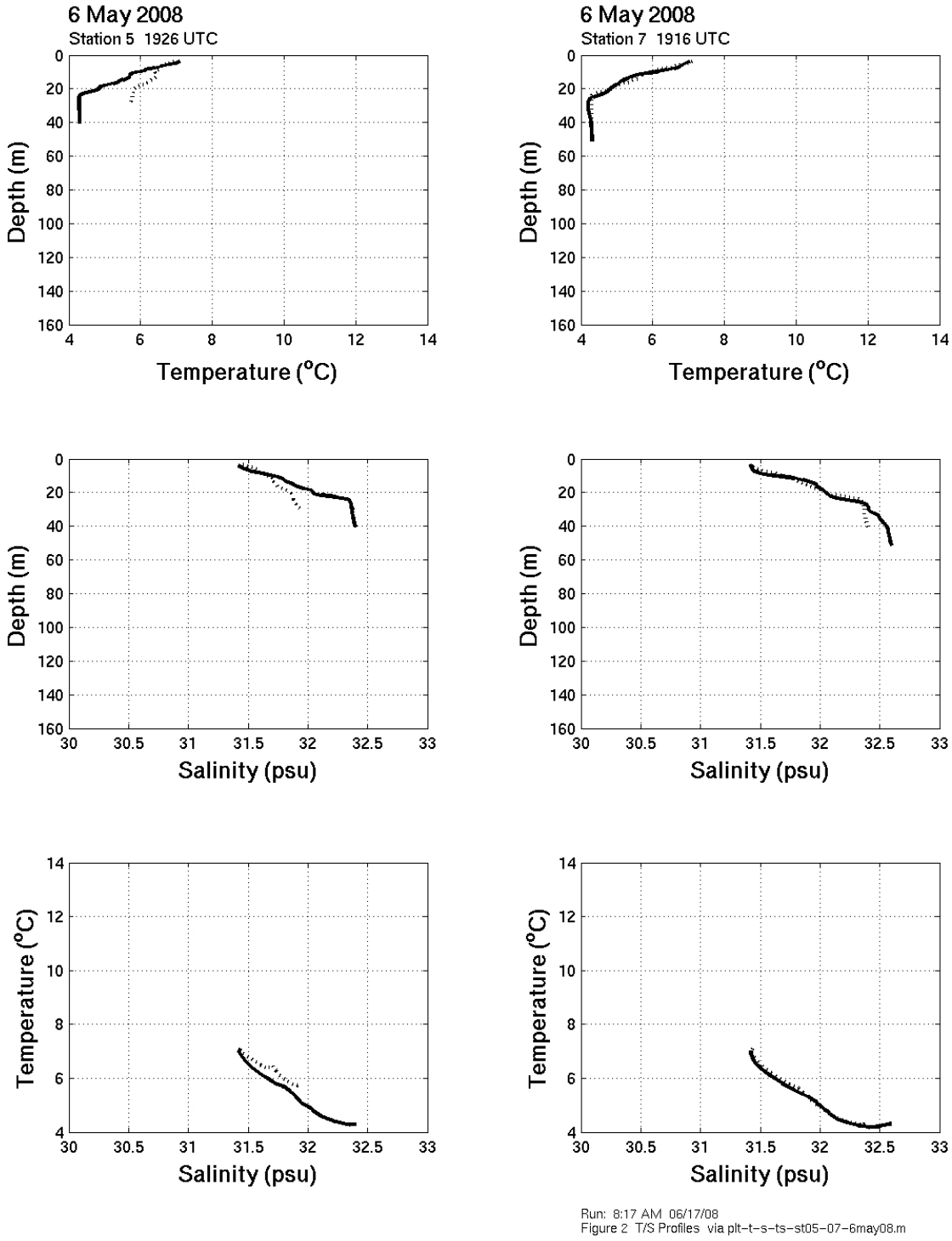

Figure A.2 Station 5 and 7 profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown. See Table 1 for station information.

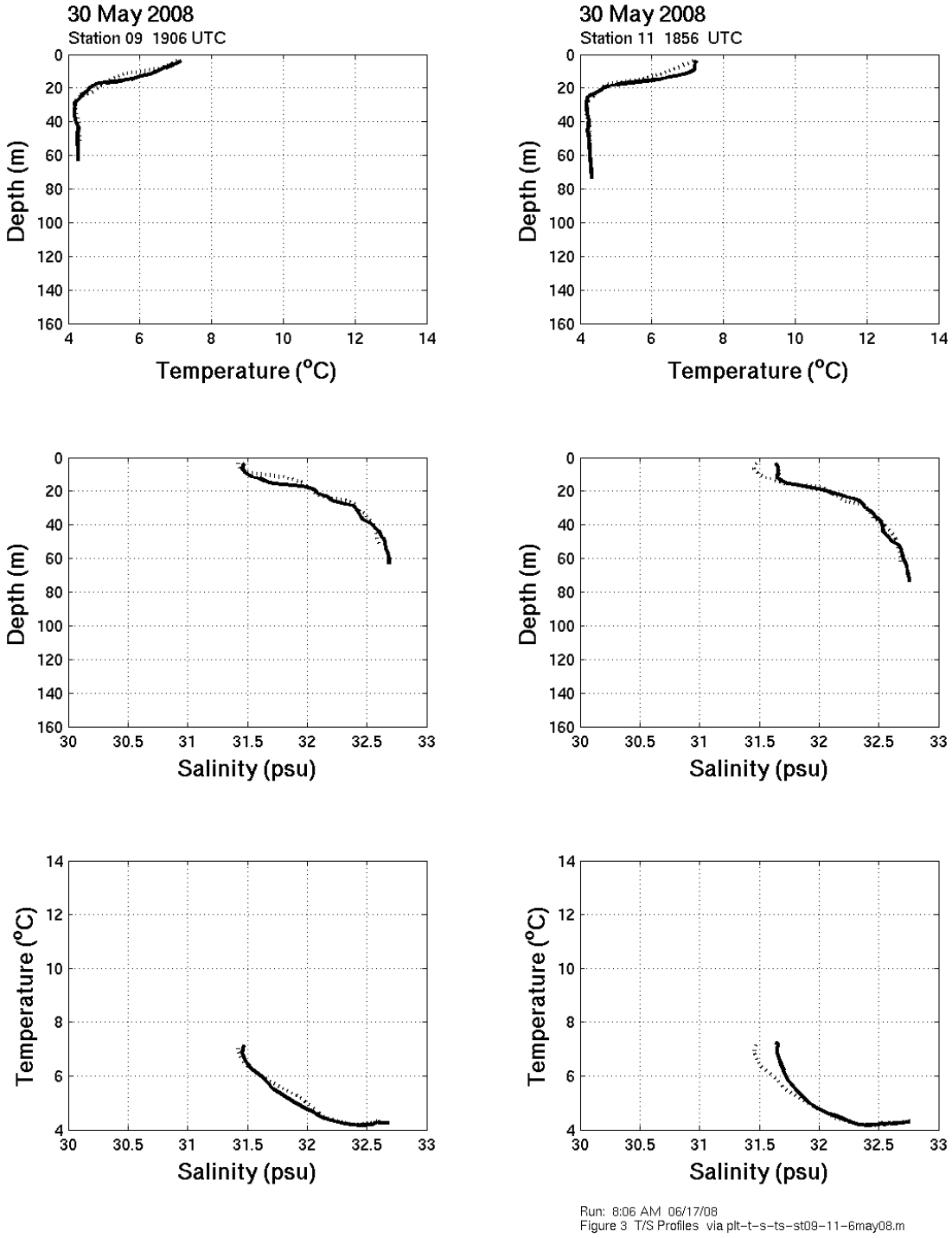

Figure A.3 Station 9 and 11 profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown. See Table 1 for station information.

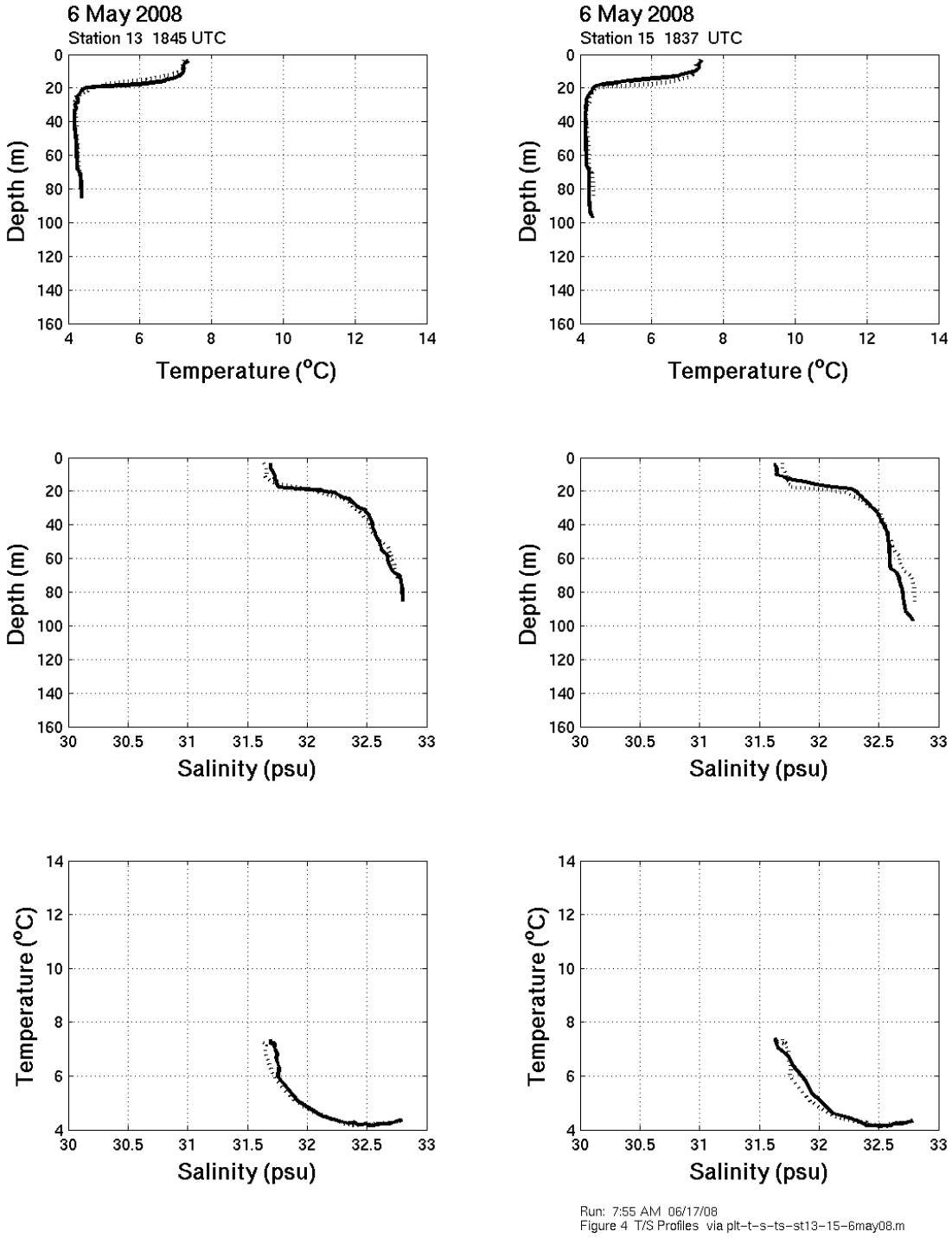

Figure A.4 Station 13 and 15 profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown. See Table 1 for station information.

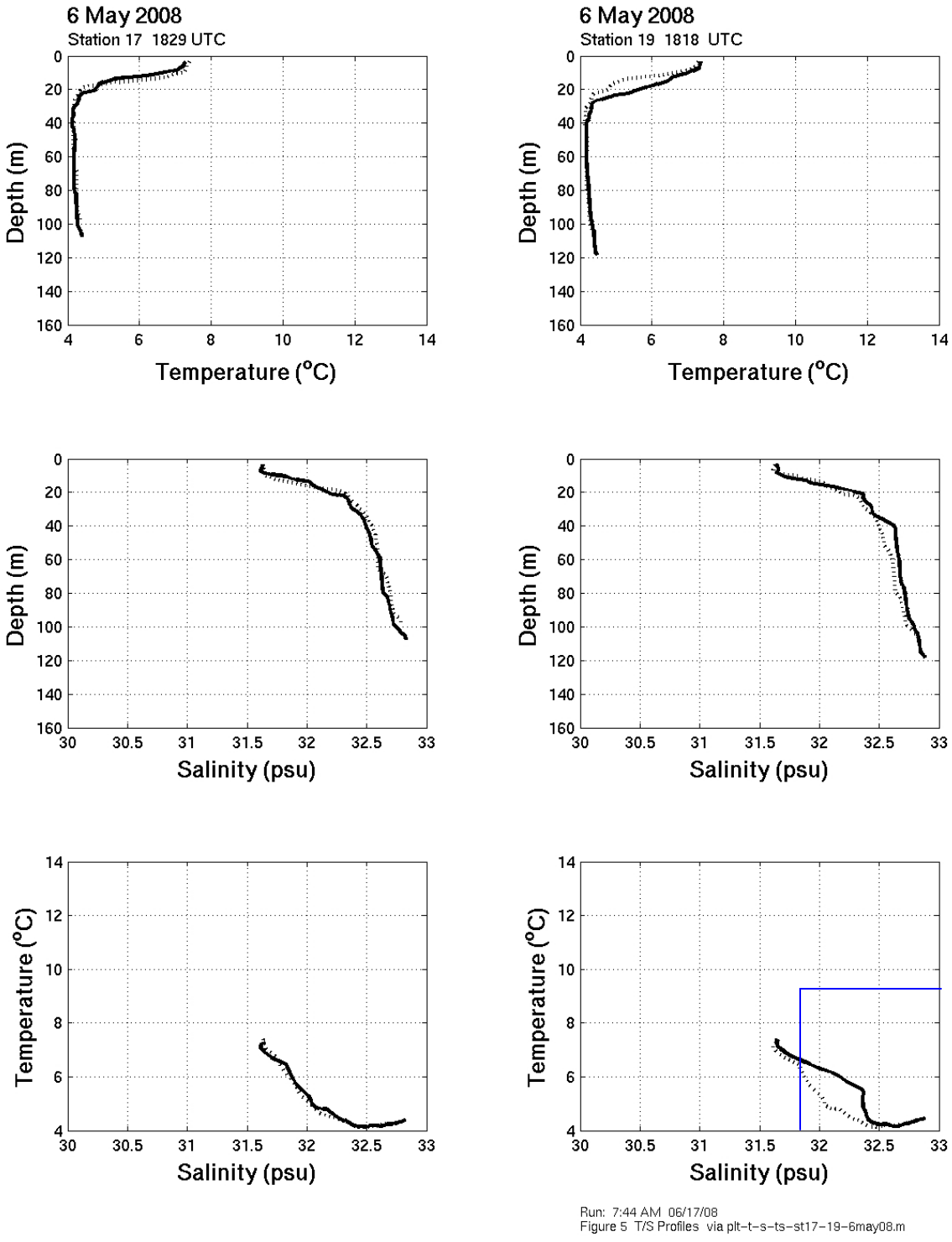

Figure A.5 Station 17 and 19 profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown. See Table 1 for station information. The lines define the limits of the cold, salty MIW mass as defined by Brown and Irish (1993).

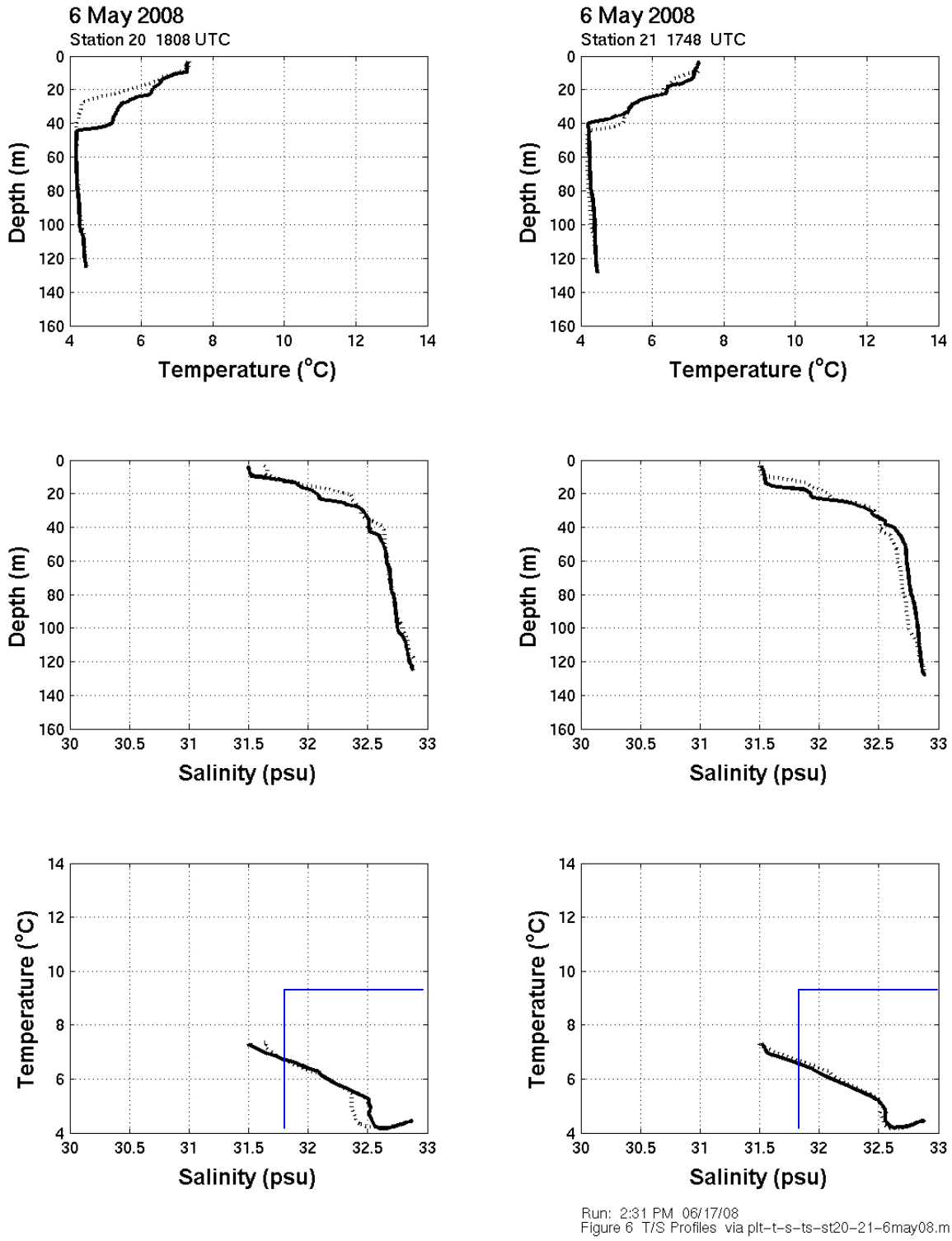

Figure A.6 Station 20 and 21profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown. See Table 1 for station information. The lines define the limits of the cold, salty MIW mass as defined by Brown and Irish (1993).

APPENDIX B. Hydrographic Profiles - 30 May 2008

The CTD profile data for the 30 May 2008 survey appears in terms of profiles and T-S relations in Figures B.1- B.8.

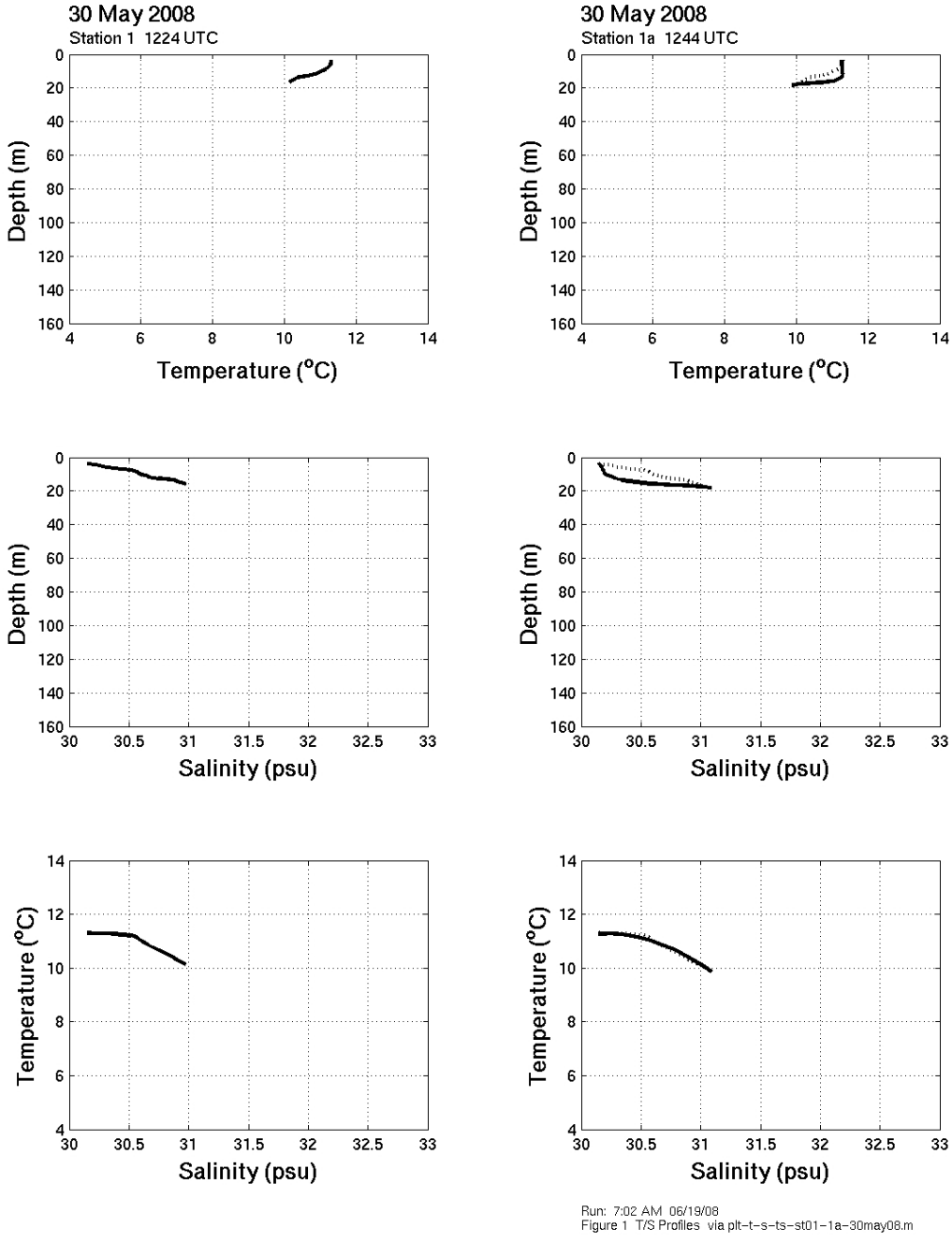

Figure B.1 The 30 May 2008 station 1 and 1a profiles of (top) temperature (T) and (middle) salinity (S); also

(bottom) T-S relations. The profiles (dotted) of the preceding station are also shown.

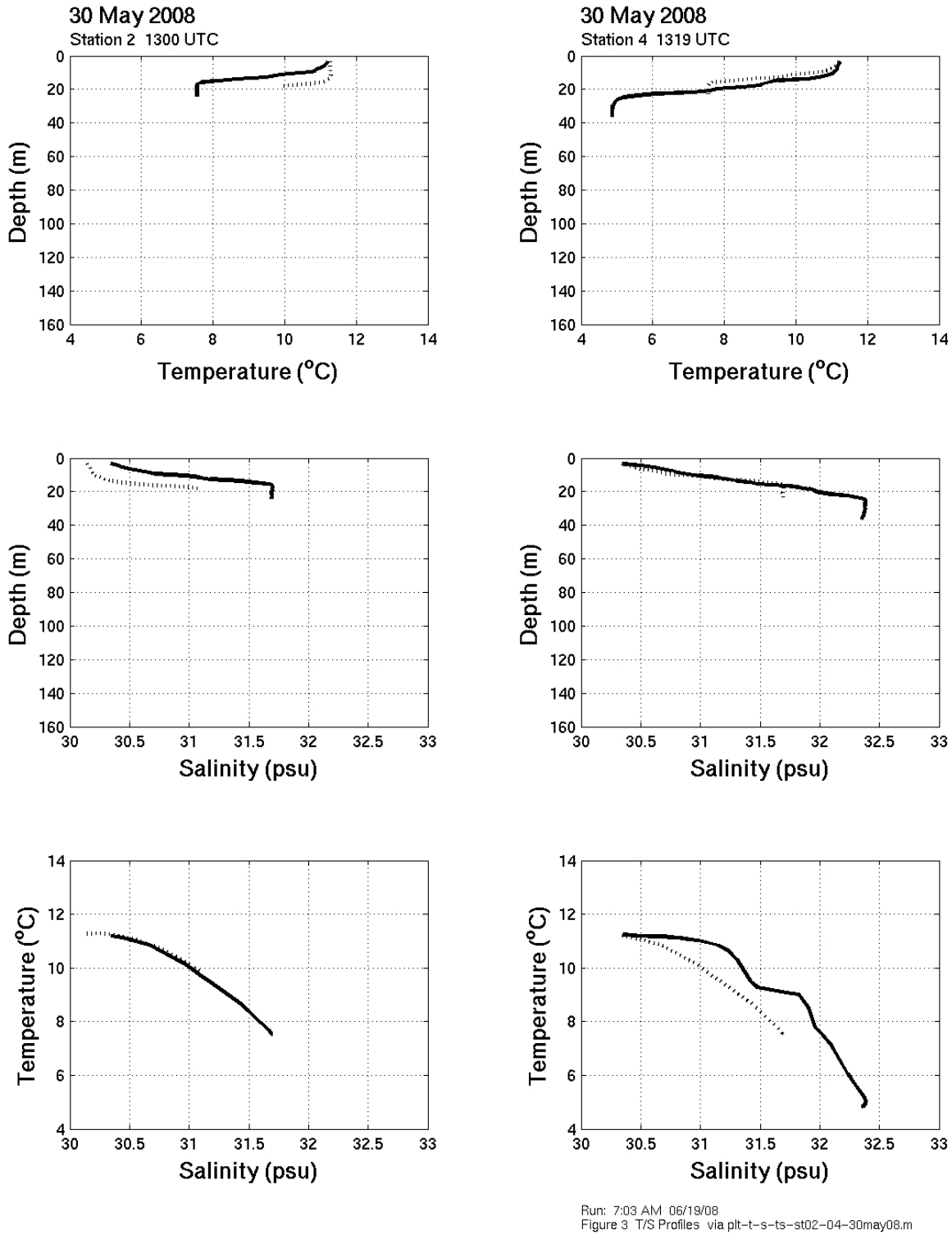

Figure B.2 The 30 May 2008 station 2 and 4 profiles of (top) temperature (T) and (middle) salinity (S); also

(bottom) T-S relations. The profiles (dotted) of the preceding station are also shown.

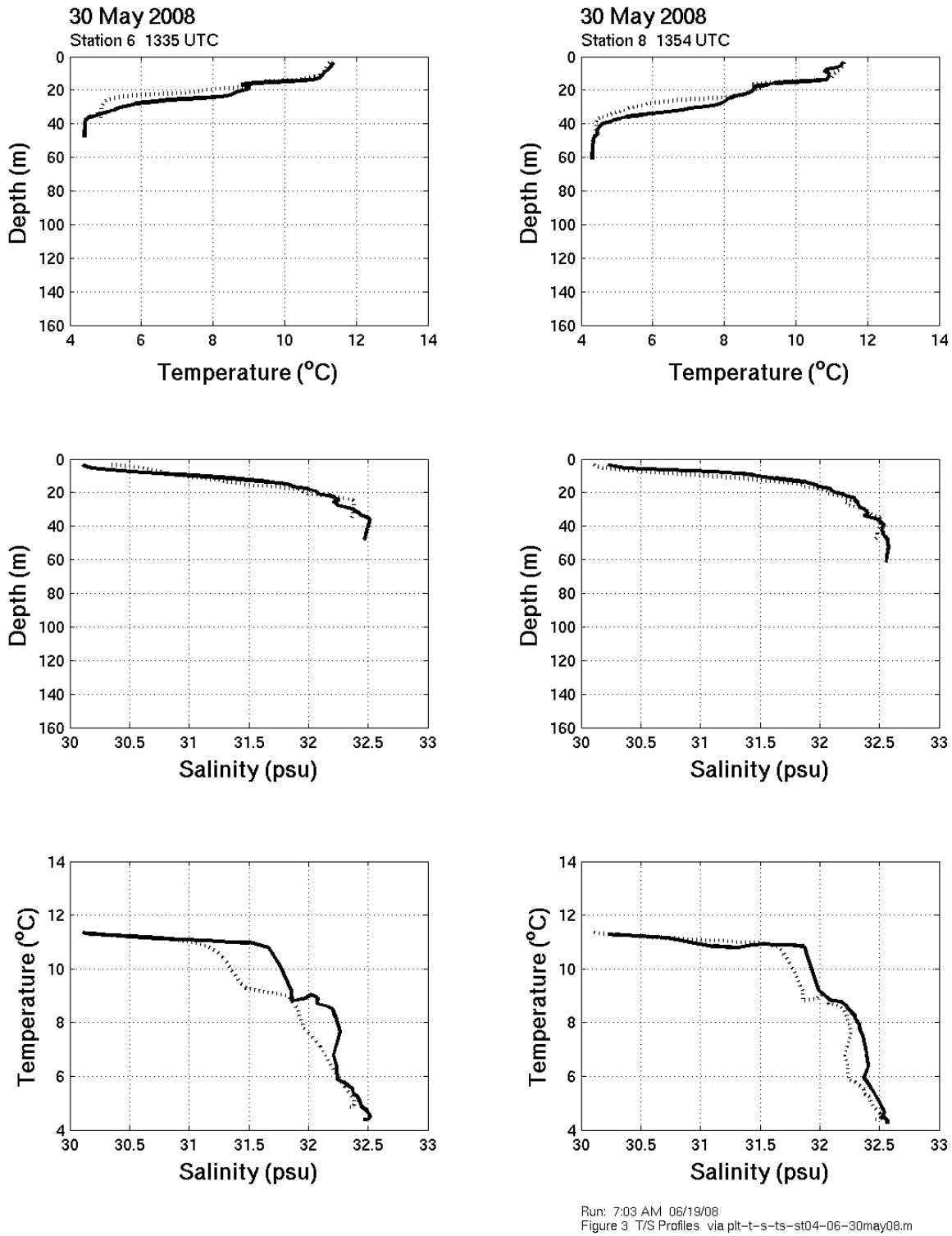

Figure B.3 The 30 May 2008 station 6 and 8 profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown.

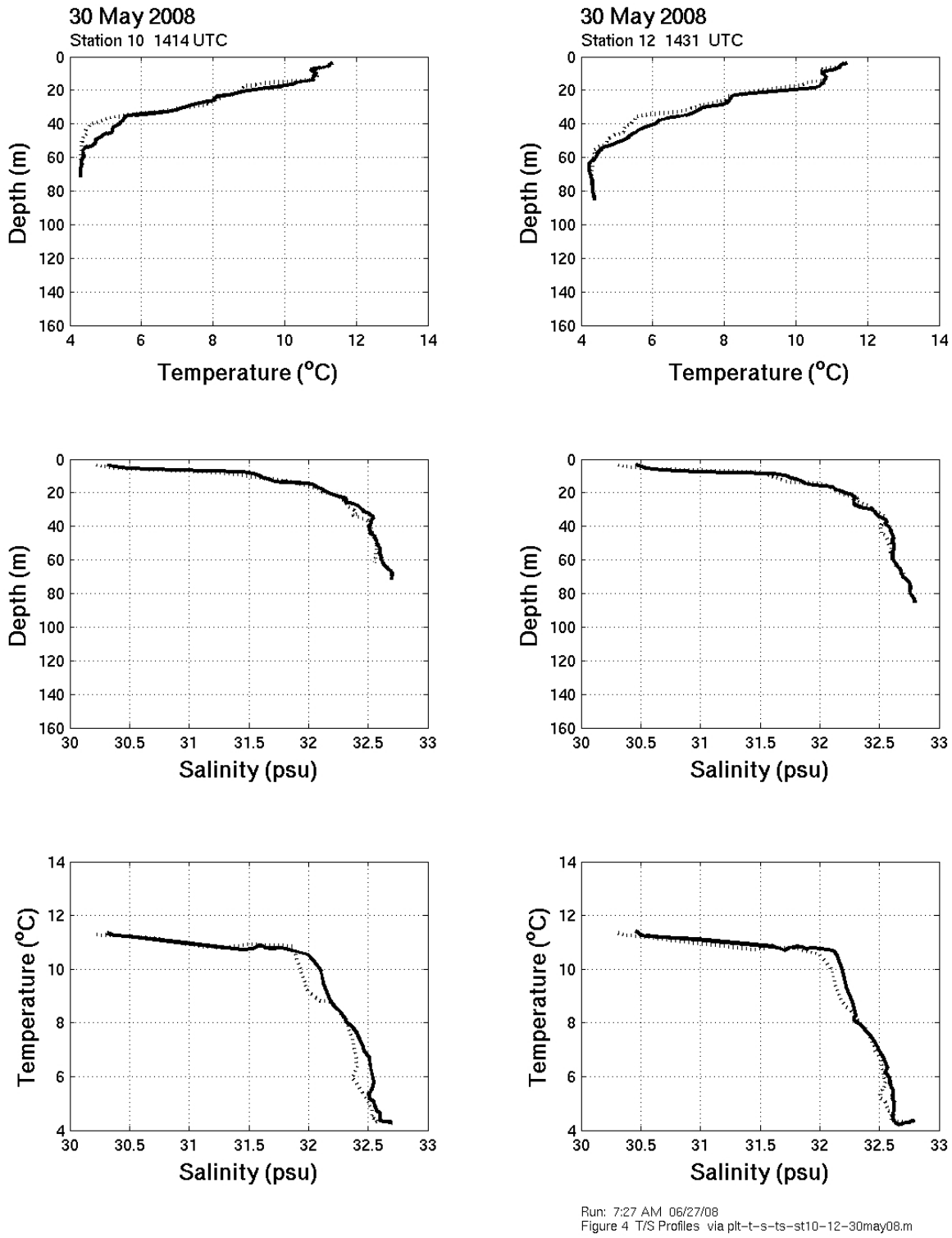

Figure B.4 The 30 May 2008 station 10 and 12 profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown.

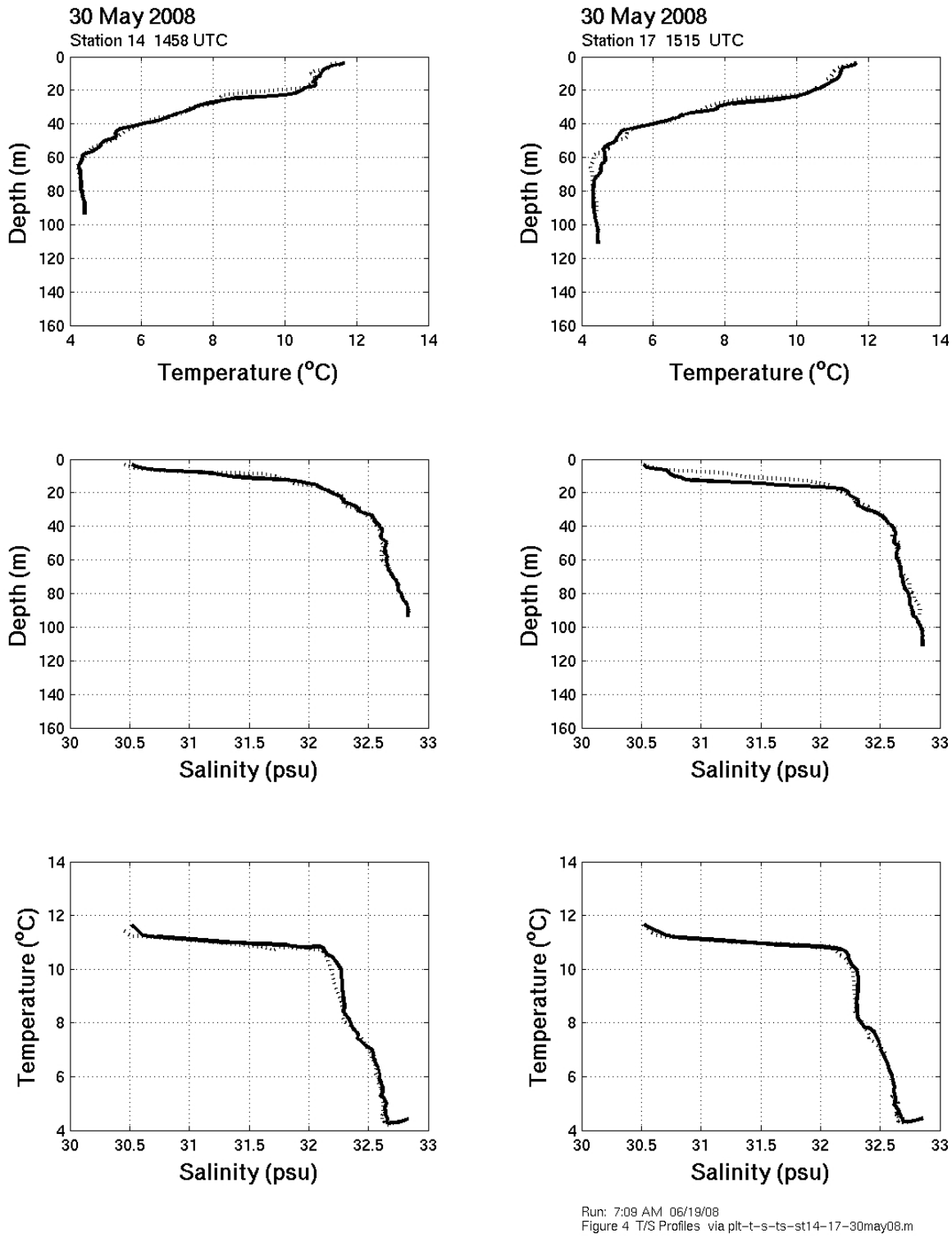

Figure B.5 The 30 May 2008 station 14 and 17 profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown.

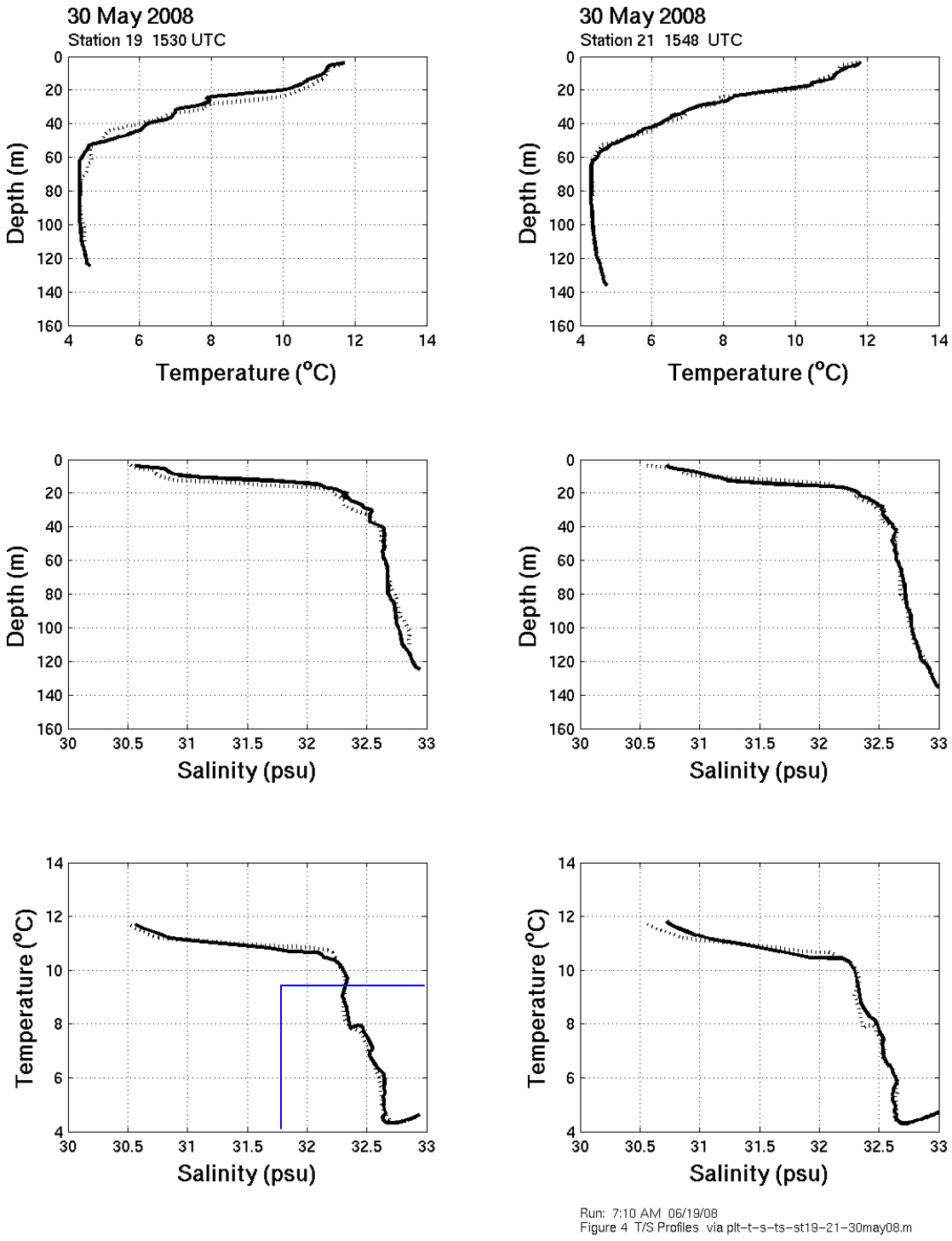

Figure B.6 The 30 May 2008 stations 19 and 21profiles of (top) temperature (T) and (middle) salinity (S); also (bottom) T-S relations. The profiles (dotted) of the preceding station are also shown. The lines define the limits of the cold, salty MIW mass as defined by Brown and Irish (1993).

APPENDIX C. The Processing Recipe for the 7May08 ADCP Data

(WSB _29may08)

in

/hosts/iselin/data01/users/wsbrown/datan/tidal_eddies/DATA.DIR/ADCP/ADCP_ascii

****

1. Hand-edit the useful ASCII data file for each station separately;
(e.g., for station #1 ....filename is nau1_ST1_12may08_edit.txt);
a) leave first 6-line header; then
b) For each 10-sec scan remove all data at depths>observed depth (see log sheet)

This yields an ASCII file with the first header followed by ~30 successive 10-sec profiles.

2. copy nau1_ST1_12may08_edit.txt ...to ...ST1_nn.txt;

3. Use l_readin< readin_tte7may08_adcp_st1_nn.PAR to convert file to 7 Ocean Format files, namely; dep_01.1; mag_01.1; dir_01.1; eas_01.1; nor_01.1; ver_01.1; err_01.1; Note that "start time" is shallowest depth in the profile with 2.0 m interval.

4. Use l_piece<piece_st2_pen_**.PAR ten (10) different times to extract the first 10 separate 10-sec scans out of out of the respective ***_01.1 files to produce - dep_01.01, dep_01.02...etc eas_01.01, eas_01.02, etc....nor_01.01, nor_01.02,.. etc.

5. Use l_header<header_st1_cor.PAR to change the headers of all of the eas** and nor** files so that they can be averaged.

6. Use l_arith < arith_aveADCP_ne_ST1.PAR to produce a 10-scan average profiles for the eastward and the northward current for each station.

7. Use l_lstats < lstats_ADCPave_st1.PAR to compare the statistics of individual eastward and northward current scans versus the respective computed average profiles.

8 Use plt_adcp_east_nor_7may08.m to plot the current profiles.

APPENDIX D. ADCP Current Profiles - 7 May 2008

The ADCP current component profile data for the 7 May 2008 survey appears in Figures D.1- D.6.

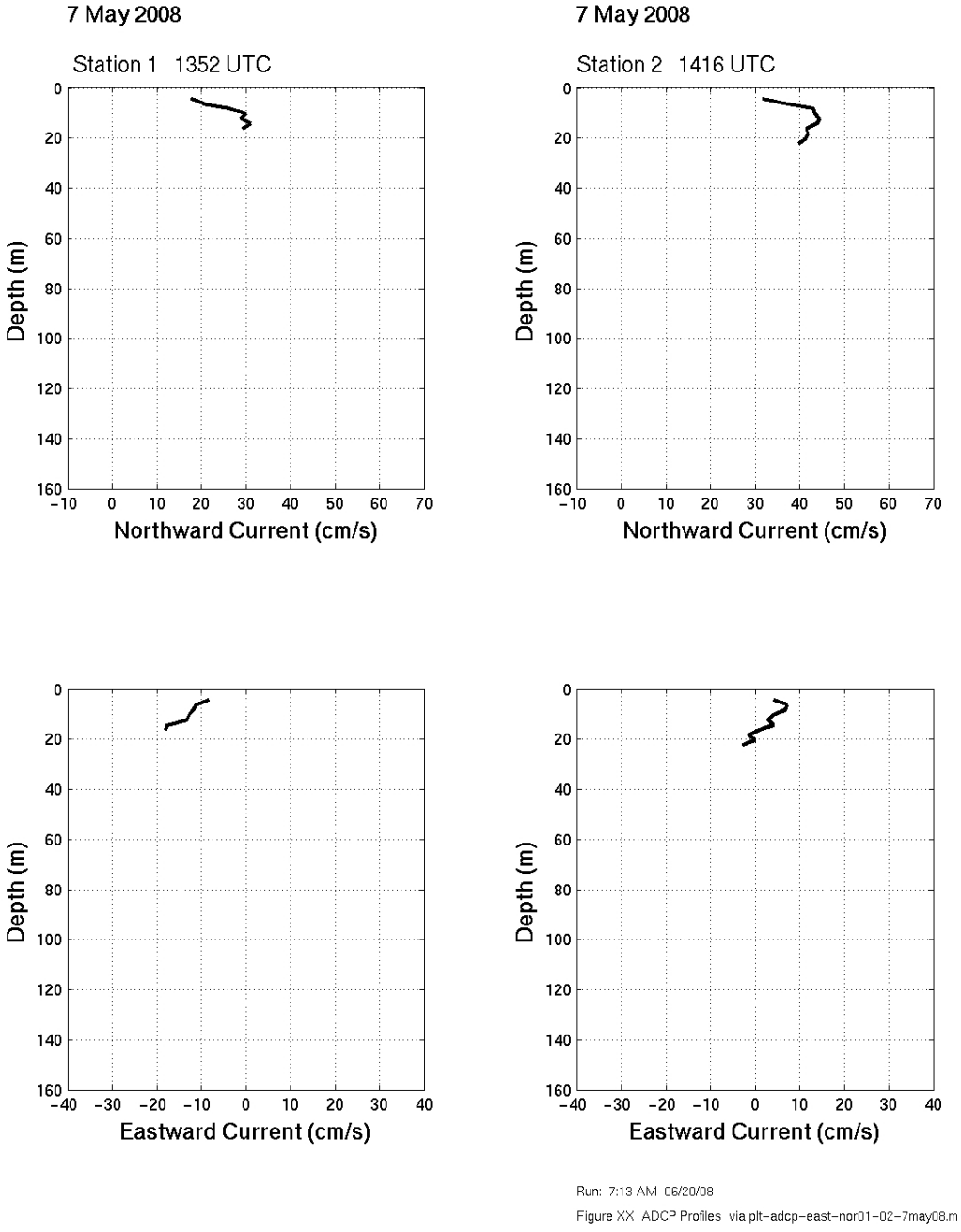

Figure D.1 The ADCP northward and eastward current profile measurements for stations 1 and 2.

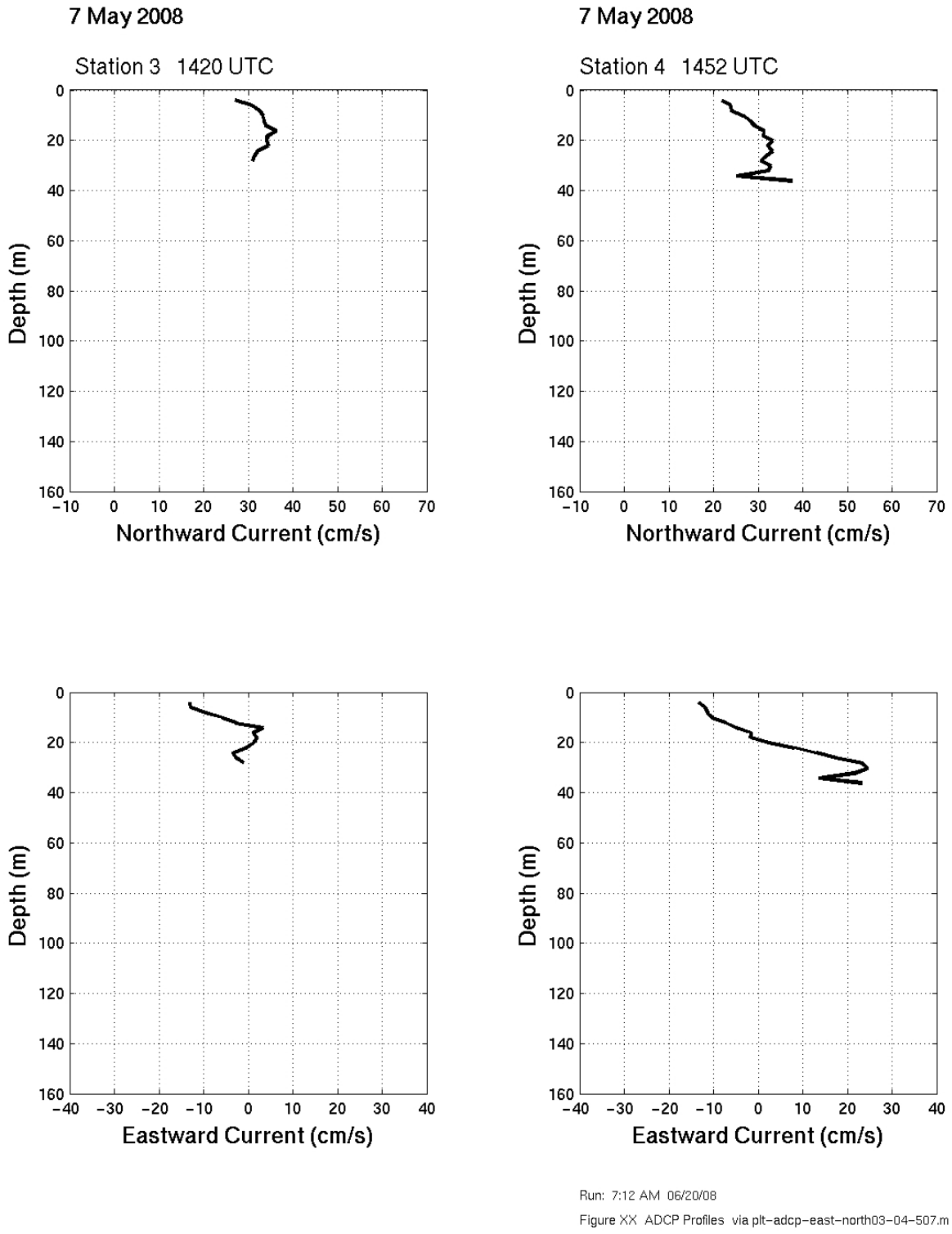

Figure D.2 The ADCP northward and eastward current profile measurements for stations 3 and 4.

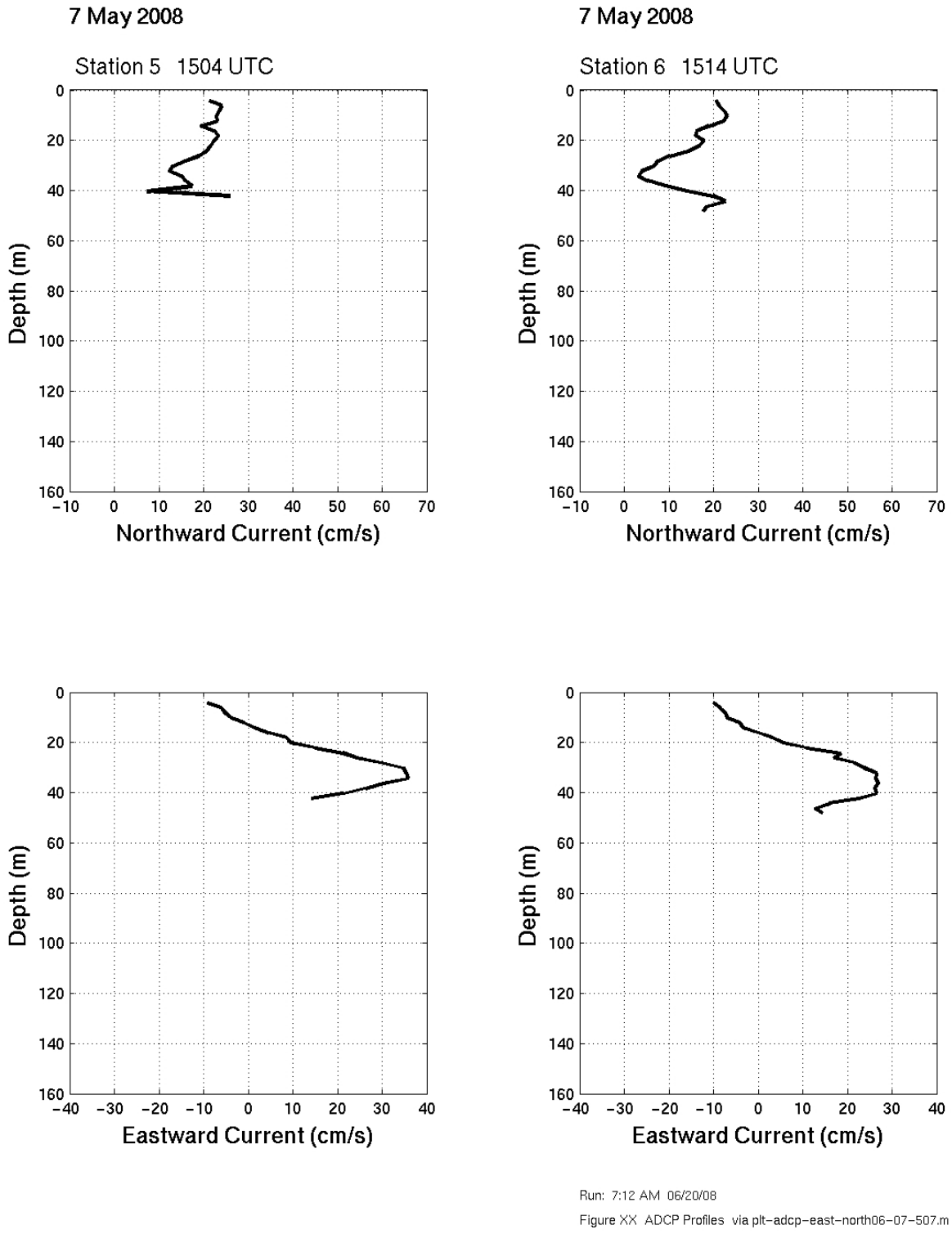

Figure D.3 The ADCP northward and eastward current profile measurements for stations 5 and 6.

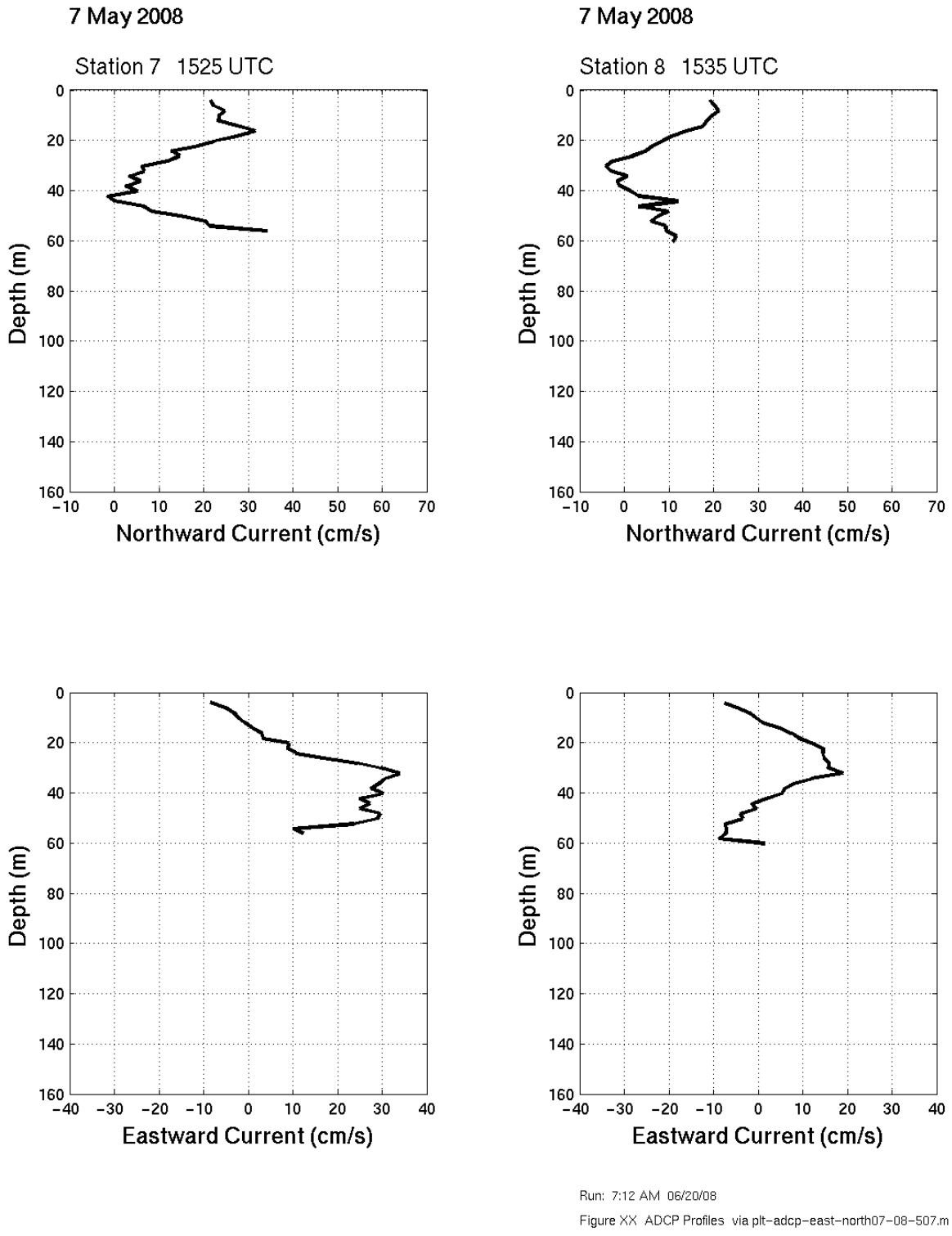

Figure D.4 The ADCP northward and eastward current profile measurements for stations 7 and 8.

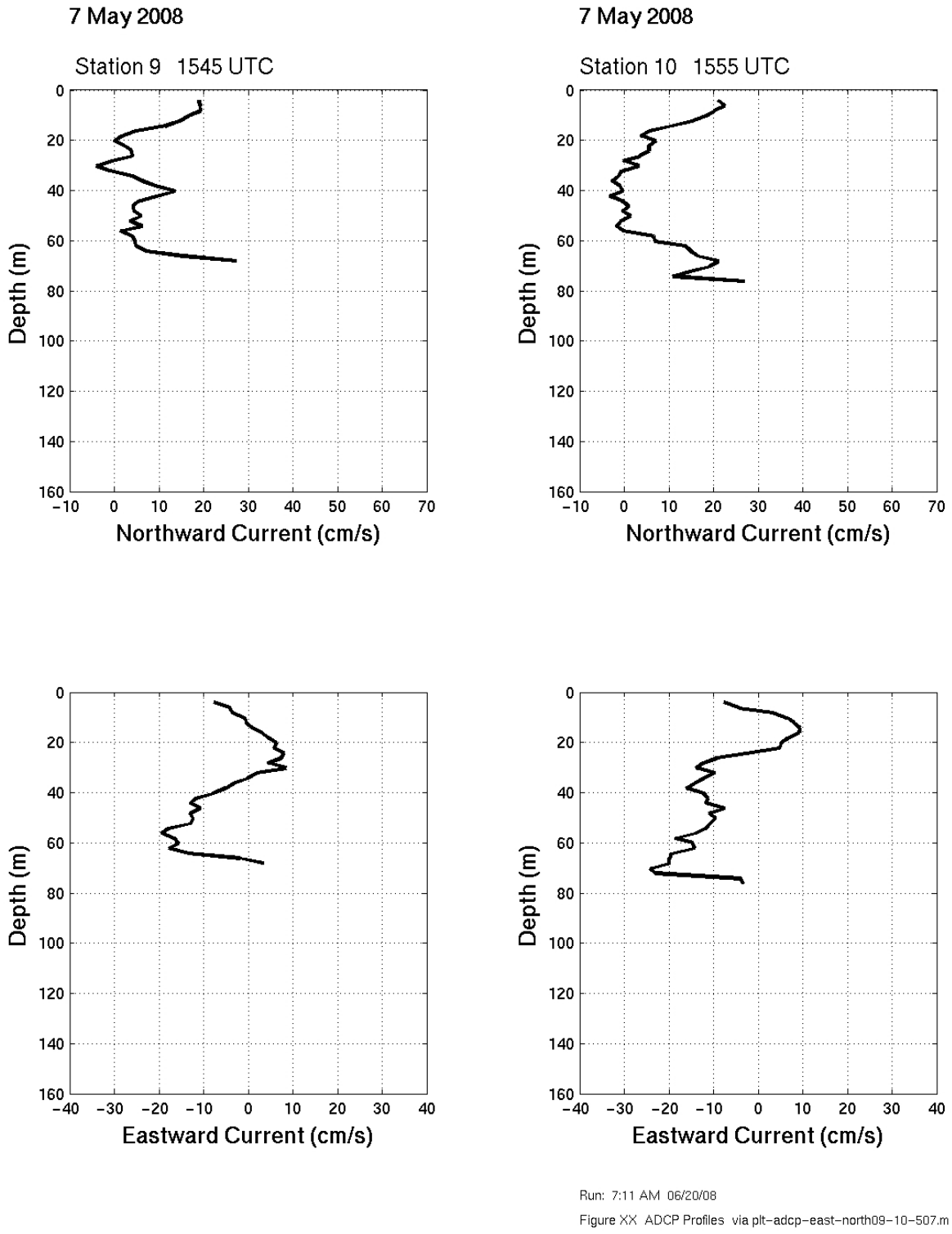

Figure D.5 The ADCP northward and eastward current profile measurements for stations 9 and 10.

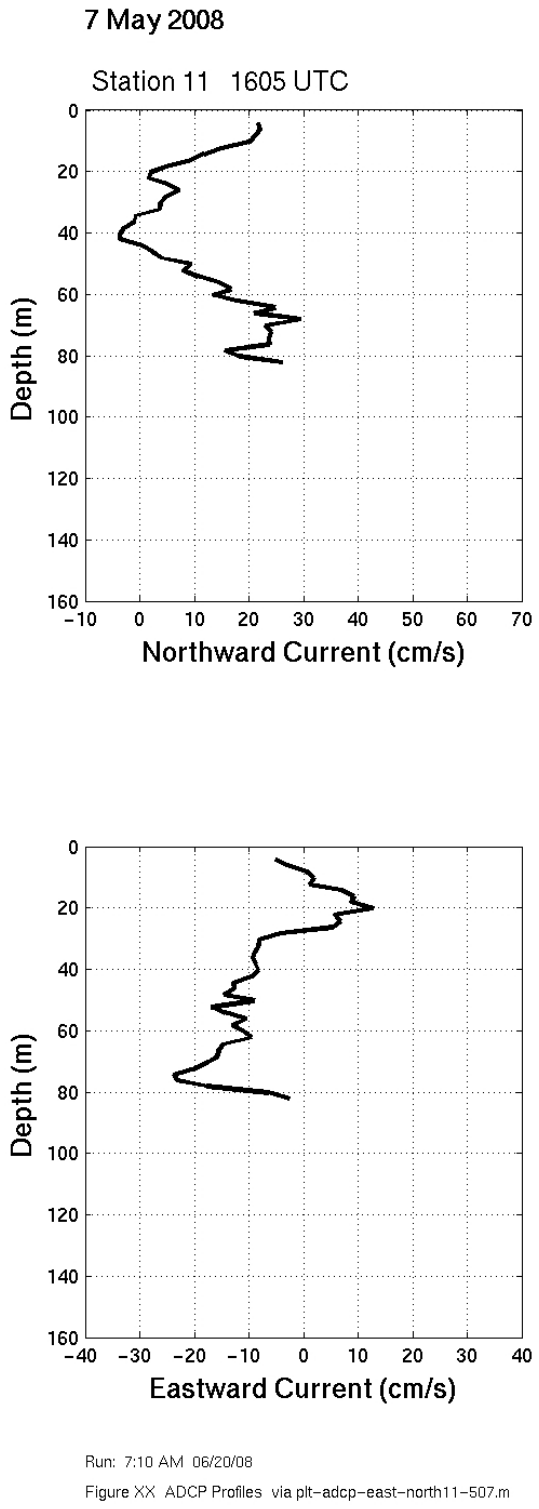

Figure D.6 The ADCP northward and eastward current profile measurements for stations 5 and 6.

APPENDIX E. ADCP Current Profiles - 30 May 2008

The ADCP current component profile data for the 30 May 2008 survey appears in Figures E.1- E.6.

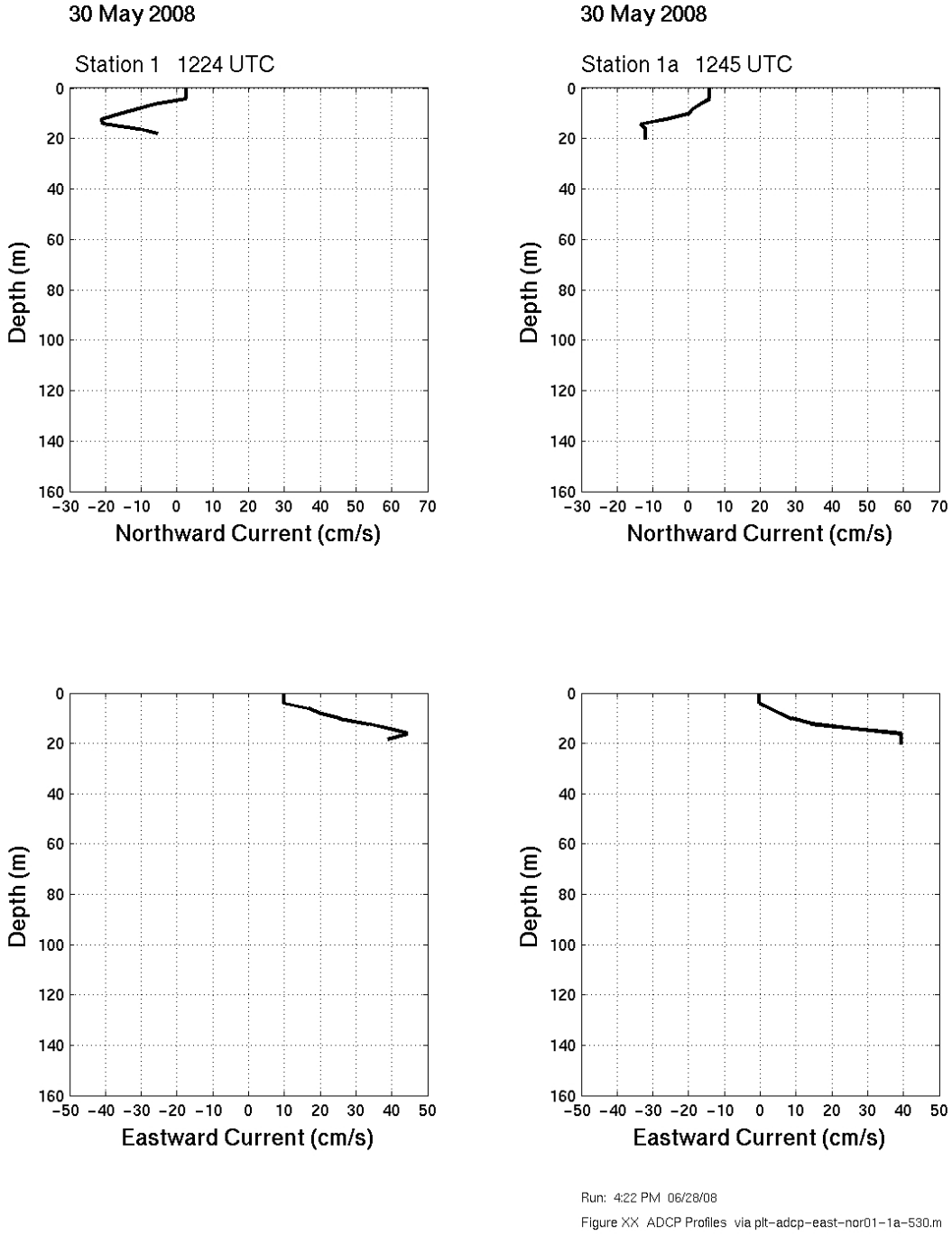

Figure E.1 The 30 May 2008 station 1 and 1a profiles of (top) northward current and (bottom) eastward current.

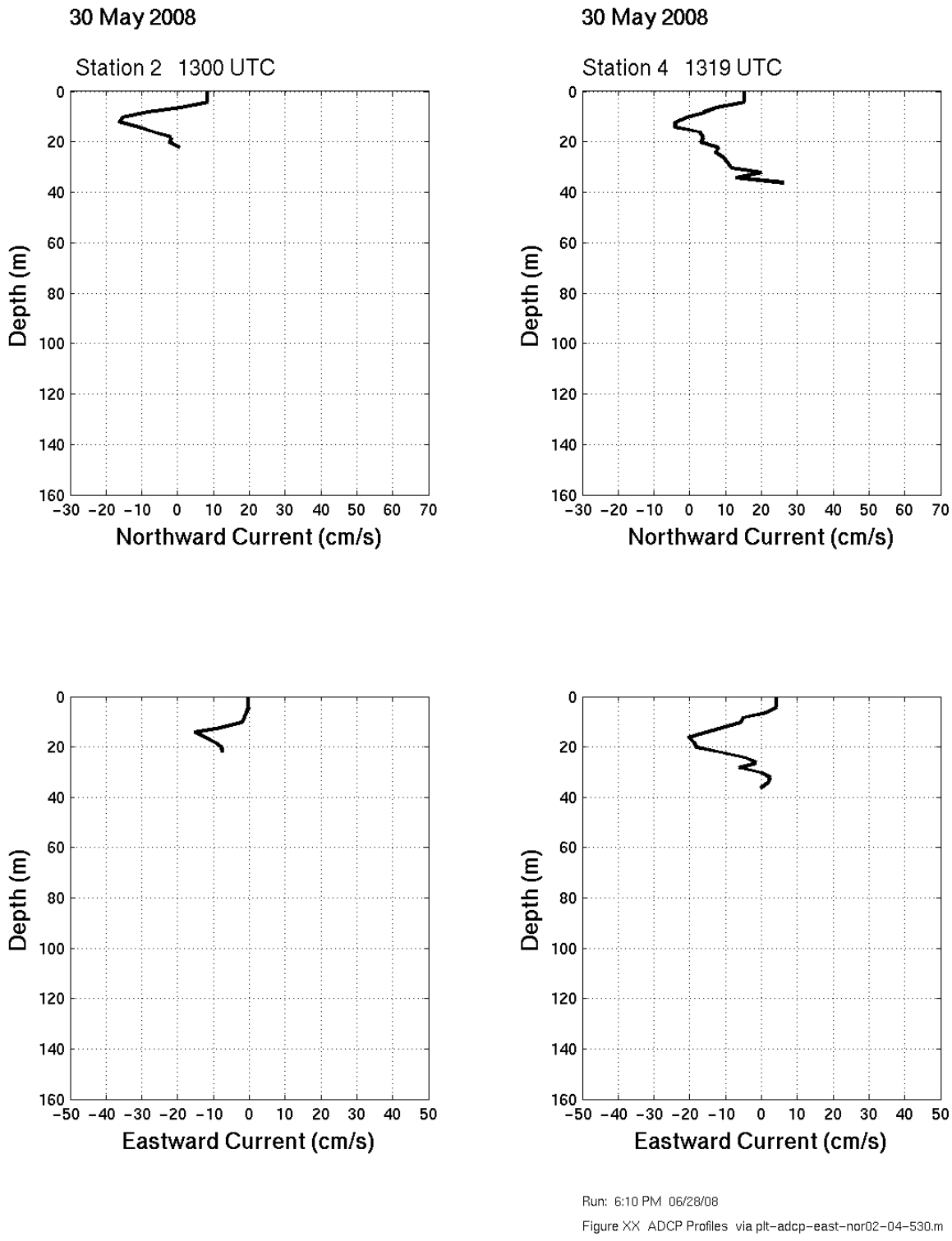

Figure E.2 The 30 May 2008 station 2 and 4 profiles of (top) northward current and (bottom) eastward current.

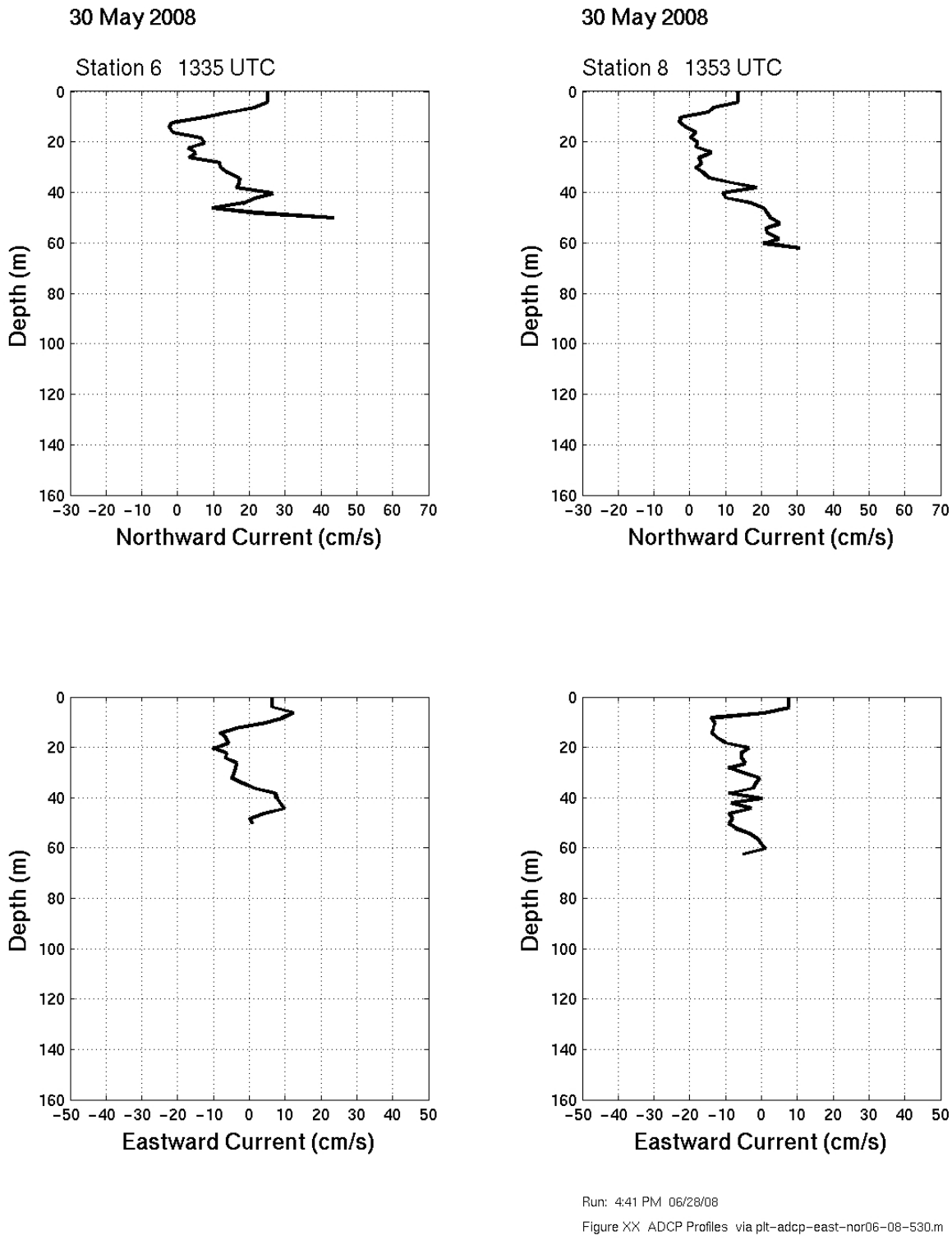

Figure E.3 The 30 May 2008 station 6 and 8 profiles of (top) northward current and (bottom) eastward current.

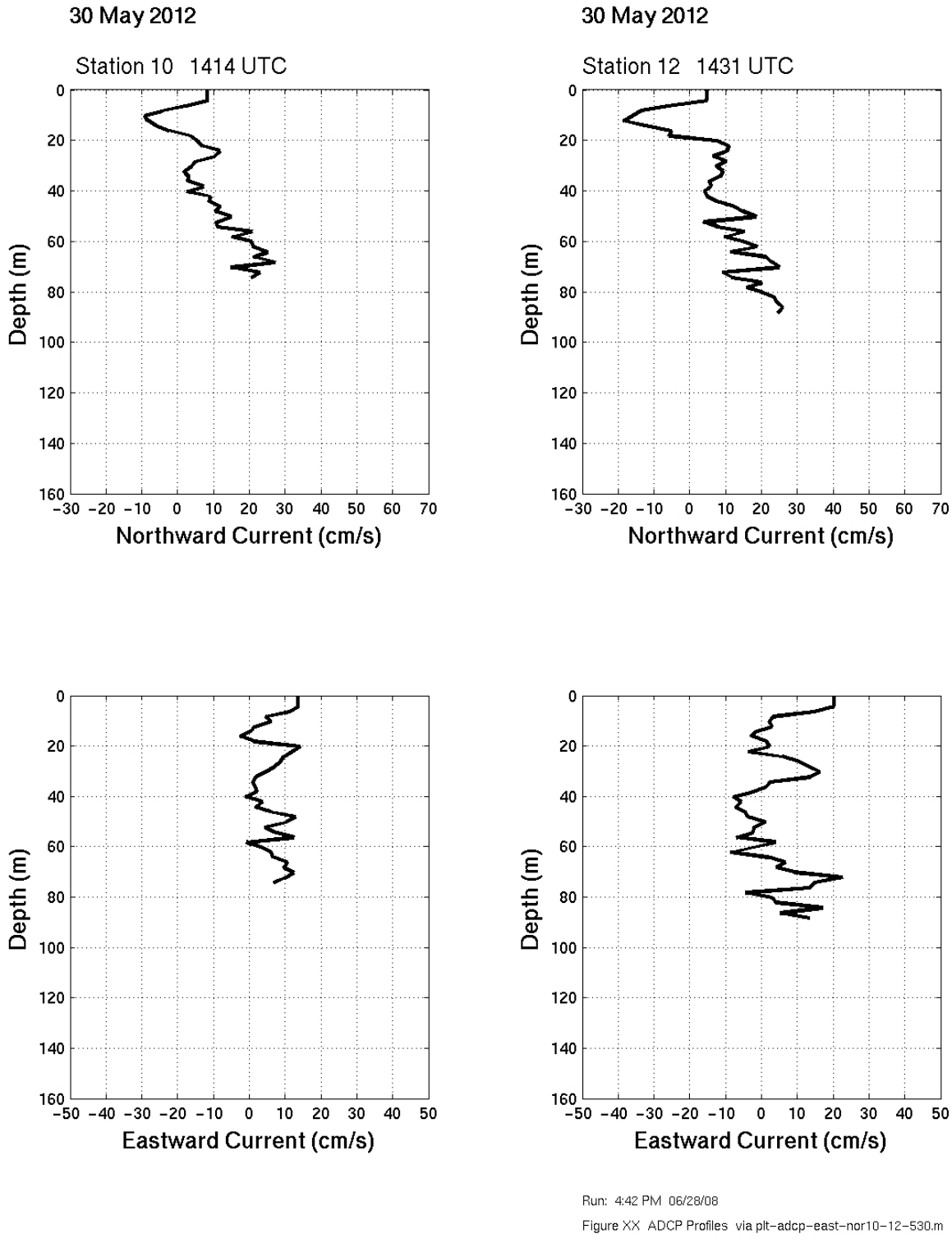

Figure E.4 The 30 May 2008 station 10 and 12 profiles of (top) northward current and (bottom) eastward current.

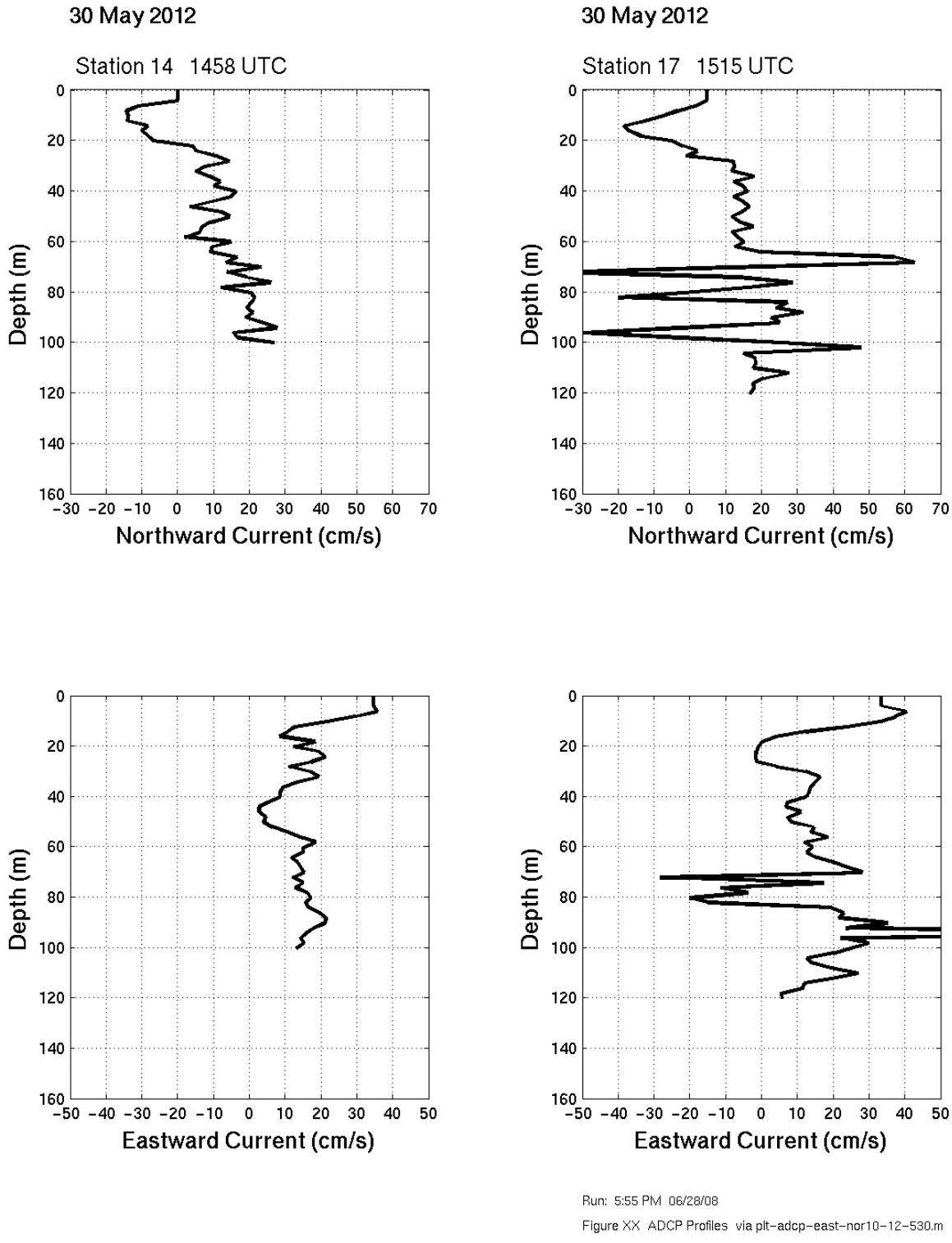

Figure E.5 The 30 May 2008 station 14 and 17 profiles of (top) northward current and (bottom) eastward current.

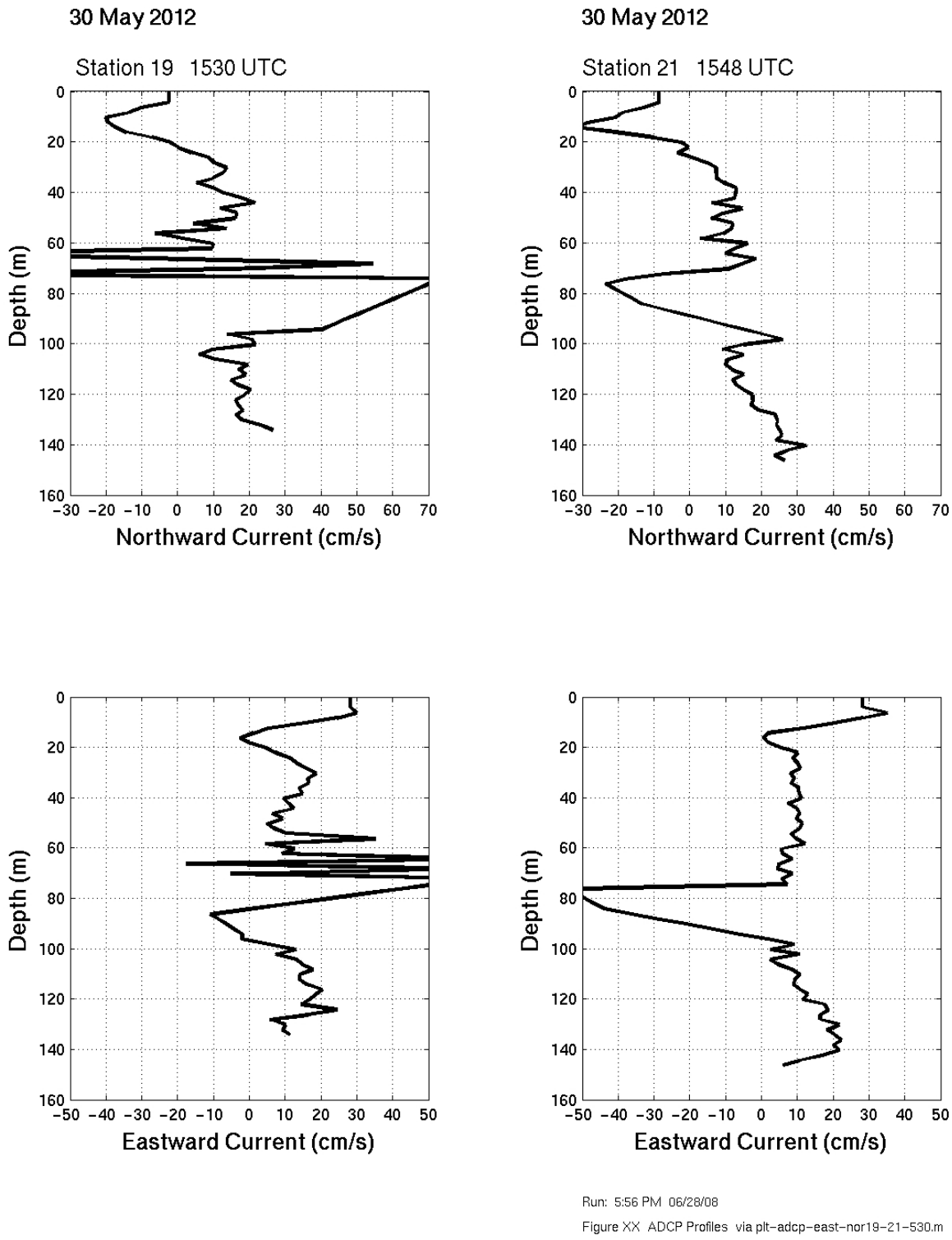

Figure E.6 The 30 May 2008 station 19 and 21 profiles of (top) northward current and (bottom) eastward current.

IV. Acknowledgements

We gratefully acknowledge the cooperation and support of the US National Park Service, who provides space and infrastructure support for the CODAR instrumentation at their Cape Cod National Seashore station at Eastham, MA - near Nauset, MA. This publication is the result in part of research sponsored by The MIT Sea Grant College Program, under NOAA grant number NA06OAR4170019, project number 2007-R/RC-104.This research has also been supported in part through a subcontract to Rutgers University who is the prime funded under NOAA grant NA07NOS4730221.

V. References

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